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# *Bulletin*

Montana Agricultural Experiment Station,  
Montana. State entomologist

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# Weeds of Montana

• By J. W. Blankinship.

[Issued September 10, 1901]



BULLETIN NO. 30.

**MONTANA AGRICULTURAL**  
**EXPERIMENT STATION**

...OF...

THE MONTANA COLLEGE OF AGRICULTURE,

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**WEEDS OF MONTANA.**

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**Bozeman, Montana, June, 1901.**

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1901.  
The Avant Courier Publishing Co.,  
Bozeman, Montana.

# Montana Agricultural Experiment Station, Bozeman, Montana.

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The Bulletins of the Experiment Station are sent free to all residents of this State upon request.

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Bulletin No. 30.

June, 1901.

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### WEEDS OF MONTANA.

J. W. BLANKINSHIP, BOTANIST.

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#### I. GENERAL STUDY OF THE WEED FLORA.

##### INTRODUCTION.

In the study of the economic features of a new state like Montana, where relatively little has been done toward a systematic biological survey of its natural productions, the botanist is seriously handicapped by the lack of available scientific collections to represent the different species of plants in the state and to show their relative abundance and distribution. Practically all this flora is of economic import, either to benefit or injure the industries of man. The forests are utilized for wood and lumber; the shrubs serve as forest nurseries, the herbs and grasses for forage. Many are capable of economic cultivation for their fruit, for shade or for ornament, while others are harmful and need restraint. Parasitic fungi attack our crops and greatly reduce the yield; many plants are poisonous to stock and cause extensive loss; some ill-flavor the milk of cows or the honey of bees; while the spines of cacti and the awns of grasses seriously injure the mouth of stock, and weeds mar our yards and highways and compete successfully with growing crops.

In order to combat these pests intelligently or to make the best use of the native plants in our industrial life, it is necessary to know their life history, their habits and their distribution within the state, and these facts can be secured only from a representative

collection of the species in a herbarium and from the study of the different plants in the field. Without this data, it is impossible to draw accurate conclusions as to the abundance and utility or harmfulness of any economic group. Although much has now been done at this Station toward securing the necessary collections of the native flora and in the study of the economic conditions of the various parts of the state, any present treatment of a large economic group, like the weeds, must of necessity be very imperfect, as large and important sections of the state are nearly unknown scientifically and several large agricultural districts have not been visited.

The study of the weeds of any region must include the sources of infection and the means by which they spread over the country when once introduced, as well as the adaptation of native plants to conditions of tillage and habitation and the means to be adopted for their restraint and eradication. The subject is of special interest in a new state like Montana, where the population is relatively scant and the agricultural districts are widely separated from each other and often from direct weed infection from abroad and where the distribution and composition of the native flora is rapidly changing, owing to the increased settlement and effects of grazing immense herds of stock over the uncultivated portions. It is also desirable to make note of the present status of these weeds in the state in order to observe their future history. Many introduced species are unsuited to our climatic conditions and die out or maintain a precarious existence here, so that they may well be disregarded as a source of danger. Others that appear harmless in the Eastern states may here develop most dangerous habits and require the combined efforts of a community, or even the aid of the state, to check their spread or effect their destruction. It is the object of this paper to present a summary of our present knowledge of the weeds of this state, to indicate the most dangerous introductions and suggest means for their restraint or eradication. It is hoped that farmers, stockmen and others interested, will send this Station specimens of any plant found troublesome or threatening to become a pest in their vicinity, so that the species may be determined, its habits studied and timely warning given to other parts of the state, that prompt

steps be taken to effect its extermination should it prove a serious danger. All the plates used are from the Division of Botany of the Department of Agriculture at Washington by whose kindness we are able to give a fair representation of many species which would otherwise be difficult to describe.

### GENERAL CHARACTERISTICS OF WEEDS.

Of the various groups of plants troublesome to man, the weeds are of prime importance because of their abundance and general distribution, and from their unceasing struggle with the farmer for the possession of the fields. The *weeds* are that group of troublesome plants, which promptly occupy soil on which the native vegetation has been greatly weakened or destroyed by the operations of man and his domestic animals and which grow and flourish under conditions of habitation, cultivation, travel and pasturage, and occur but rarely removed from these conditions. They are objectionable because they tend to crowd out plants more desirable in our lawns, meadows and pastures, because they render our yards, streets and waysides unsightly and spread thence into our gardens and fields, where they choke out the growing crops and rob them of needful food and moisture, and because their seeds, mixed in the grain used for food by man and stock are unpalatable, or even hurtful. Yet, in most of their characteristics, weeds differ from cultivated plants only in their lack of economic value and their greater hardiness, and the cultivated plants themselves, under favorable conditions, not infrequently escape and become pernicious weeds, like the carrot, radish and turnip in certain sections of the Union.

But there are certain characters and adaptations of weeds, which enable them to grow and spread faster than other plants and give them a peculiar relation to civilized life.

Their habit of occupying lands denuded of their natural vegetation renders them free from all competition except among themselves. They have often wide-spreading basal leaves and spreading or prostrate branches, which enable them to crowd aside other plants, or their vigorous growth permits them to overtop and shade out more slow growing species. They are usually protected against herbivorous animals by growing within fenced

enclosures or in streets and lanes, where there is less pasturage. Those found in meadows and pastures are frequently acaulescent (stemless), like the dandelion and plantain, while along streets and highways they are often prostrate, as in the case of pigweed pursley, knotgrass, vervain, carpet weed, and wild tomato, a habit which puts them beyond the reach of most grazing animals. Many have bitter or poisonous secretions or excretions which cause them to be avoided by animals, and others develop spines, prickles or stinging hairs for the same purpose. A considerable number of weeds are able to germinate on and penetrate with their roots the packed soil of street and roadside and to withstand the excessive dryness of the later summer, when many other plants would die under similar conditions.

But one of the most remarkable characters of weeds is their wonderful power of reproduction. Many annuals begin blooming almost as soon as they are out of the ground and produce seed until the frosts of autumn, not rarely going through several generations in a single season, while the number of seeds produced by a single plant often mounts up into hundreds of thousands. With most other plants the season is far advanced before they attain maturity, or their period of fruiting is limited to a short season in early spring and the number of seeds produced is relatively small. The seeds of many weeds are also remarkable for their vitality, and are often able to germinate a dozen or more years after being exposed to ordinary soil conditions, and it is this property which renders the sunflower, wild oat, wild mustard, pigweed pursely, wild tomato, tumble-weed and others so difficult to exterminate when they have once become established. A number of species are more or less fleshy so that they are able to take root again after being dug up, or are at least able to mature the seeds already set, and this habit makes them palatable for stock and thus aids in the distribution of their seed. The large fleshy roots of the dandelion and docks are difficult to kill while the underground stems of the wild morning glory, the Canada thistle, sheep-sorrel, milk-weed, wild liquorice, &c., not only spread the parent plant, but are even aided by the processes of cultivation.

But weeds also labor under certain disadvantages. Nearly all species are desirable food for stock, of which they take advantage

to scatter their seeds. By far the larger part are annuals and are hence unable, when left to their own resources, to long compete with the more enduring native species. Biennials are particularly weak, being unfitted for the annual upturning of the soil in cultivation or for extended contests with the perennial species, finding their natural conditions only in waste places and along highways. Weeds must also contend in unceasing passive warfare with man, whose interests they endanger, but who provides them with conditions best suited for their growth.

### MEANS OF DISTRIBUTION.

Weeds, like other plants, are dependent upon physical agencies for the distribution of their seed, but rely more largely upon man and domestic animals for this aid. It may be well to enumerate a few of the principal means thus employed.

A considerable number of species depend upon the wind to scatter their seeds and such weeds produce feathery, hairy or winged seeds or have their seed envelopes so modified as to aid in such dissemination. Among these are the thistles, fireweed, dandelion, milkweed, sow-thistle and rag-weed (*Erigeron*), while the docks, pennycress and orache are likewise assisted by their winged fruit pods and appendages. Again, a group of plants called "tumble-weeds," adapted particularly to the plains, grow in large globular clusters and have the curious habit of breaking loose from the ground in the winter and are then rolled about over the country by the wind, scattering their seeds throughout their course. We have here the tumble-weed (*Amaranthus albus*), the tumbling mustard (*Sisymbrium altissimum*) and the Russian thistle (*Salsola Kali* Tragus), while the tumble-grass (*Panicum capillare*) is found to some extent eastward.

Another large class depends more particularly upon the water for seed transportation and such seeds have light, water-proof envelopes, which enable them to float for considerable distances before saturation. Indeed, the seeds of nearly all weeds are thus distributed to a greater or less extent, but the sunflower, the horse-weed (*Iva*), wild mustard, pigweeds and the sweet clover seem to depend mainly upon irrigation for their spread, and the docks come largely under the same class.

A third class requires the agency of animals to assist their migration. Some of these have hooked, barbed or awned fruit which cling to the fur and wool of stock and hence are particularly injurious to the wool industry of the state. Among them may be mentioned the cockleburs, beggar-ticks, wild liquorice, buffalo-bur, spear-grass and foxtail. The weeds so common along streets and highways, in yards and pastures, are distributed mainly by the mud of passage, which adheres to the feet of animals and the wheels of vehicles, while the adhesiveness of a considerable number is further increased by developing a gummy secretion from their outer coat or envelope to assist in the process. These seeds are usually small and frequently depend in part upon water for their extension. Those with mucilaginous envelopes are the plantains, shepherd's purse, bird-seed (*Lepidium*), *Matricaria*, *Monolepis* and *Euphorbia*, while the sticky contents of the berry of the wild tomato serve a similar purpose. Many of these weeds are edible and have small seeds with impervious coverings, which enable them to withstand the various processes of digestion and they are thus scattered in the offal of animals. Hence barn-yard manure is a prolific source of weeds and always tends to restock our fields with these pests.

But the agencies above enumerated tend only to scatter weeds already established in a community, while foreign species come in chiefly through the agency of man, and it is against these introductions that we are able to guard most effectively. A large number of these imported weeds first reach us through the railways traversing the state, being transported in merchandise, in hay and in the bedding of stock cars and these seeds are dropped en route or in the transfer of goods at the several stations. Hence, it is a matter of common observation that new weeds are frequently first observed along the railways and in the vicinity of such stations. The Russian, the Canada and the Scotch bull thistles seem to arise mainly from this source.

It is probable that the chief means of foreign infection is through the importation of impure seed. New weeds are constantly appearing in our fields and gardens traceable directly to this source and all such weeds should be promptly exterminated before they secure a foothold.

A great part of the weeds of the grain fields, besides providing for independent distribution, ripen their seeds at the same time as the cultivated grains and depend upon the farmer to exercise like care in planting them again. Hence it is necessary, if these weeds be kept out of our fields, that all seed sown be first carefully winnowed, and thus the farmer may later be saved much labor and expense in their extermination, or in the reduced yield from the grain planted. The cockle, sunflower, wild oat, and wild mustard are largely distributed in the seed planted and these are counted among the worst weeds in the state. Garden and lawn seeds are notoriously contaminated and the most troublesome weeds of the East are thus imported, particularly the dandelion, plantain, chickweed, sow-thistle, ragweed, Canada thistle and many others equally troublesome.

#### ORIGIN OF OUR WEED FLORA.

Some plants in every country acquire the weed habit by adaptation to meet certain conditions, which have resulted in the destruction of the normal vegetation over areas more or less extensive and of fair permanence. Under natural conditions such denuded soil is found in cases of forest fires, landslides and floods. The first two are of infrequent occurrence and the areas effected are soon re-covered, mainly with wind-disseminated species. The floods resulting from melting snows and spring rains are fairly regular in time and permanent in place, so the alluvium deposited each season affords a fertile and permanent ground for the growth and reproduction of the seeds transported in the water. It is these native alluvial weeds, of which the annual sunflower and the horseweed (*Iva*) are examples, that spread so readily to our fields and gardens with the water used in irrigation and there become permanent pests.

To an appreciable extent, too, weed conditions are afforded by the soil excavated about ant hills, gopher burrows and prairie-dog towns, and here flourish in abundance such species as *Krinitzka crassisejala*, *Echinosperrum Redowskii*, *Plantago Patagonica*, *Malvastrum coccineum* and *Cleome integrifolia*, which now find themselves equally well adapted for growth in yards, streets and waste places. But man in his various pastoral, agricultural and

commercial operations, is the chief agent in providing conditions suitable for weed growth.

The occupation of a country by nomadic tribes or a pastoral population essentially disturbs the previously existing balance of native vegetation in that region. The native species are killed about the temporary camps and habitations and the pasturage of flocks and herds tends to reduce or even exterminate many of the more nutritious forage plants and to introduce others, which take the place of those destroyed. A large proportion of the weeds of the Plains probably owe their wide distribution to the Indian and the buffalo, and the stockgrowing industry has merely continued and extended the conditions previously prevailing.

The change in the flora following the settlement of a country by an agricultural population is relatively much greater, owing to the increase of population and the extent of the changes produced by cultivation, travel and commerce which facilitate the introduction of many foreign species.

Thus the weeds of any particular region are of two kinds native (or indigenous) and introduced, the latter coming in from other regions adjacent or remote. It is often desirable to separate these two groups, as it is manifestly impossible to prevent the introduction of species already a component part of our flora, while the foreign species may be prevented from securing a foothold, exterminated, or confined to certain limited sections already invaded.

In the older and more densely populated states it is often difficult to distinguish the introduced plants from the native species without long study and careful comparison over an extended area, and systematic botanists are often lax in this discrimination. In a new state like Montana, the problem is greatly simplified because of the sparsity of settlement and because the sources of weed infection are relatively few and easily traced. Even here many introductions pass as native species by reason of their abundance in certain sections and our uncertainty as to their natural distribution, yet there are certain rules by which we may form a fairly correct judgment as to whether a given species is native or introduced. In general, other conditions being the same, we may infer that a species is introduced if—

1. It is most abundant at the supposed point of introduction, decreases in numbers departing therefrom and is wholly absent in distant or isolated localities.

2. It does not occur in isolated localities growing wild under natural conditions and forming an integral part of the indigenous flora, or is known to be a recent introduction into such localities.

3. It is sporadic in localities widely separated and is much more abundant or occurs in greater perfection in another region from which its introduction may be inferred through known agencies.

4. It is normally found occupying localities in which the native vegetation has been weakened or destroyed by the presence of man and his domestic animals and is rare or lacking in the country adjacent.

The source of its introduction is (1) from a region of its known occurrence adjacent or remote, or (2) from the direction of its greatest abundance in the state, or (3) from the usual source of seed importation into the state, or of travel through it.

Judged by these criteria, the following species may be considered indigenous, although a number (here starred \*) by their present restricted distribution in the state and the fact that their bounds are being still extended, indicate that they are of comparatively recent introduction and may best be termed "subindigenes," while a few (†) are doubtful.

## I. ANNUALS.

- |  |  |
|--|--|
| * <i>Amaranthus albus</i> , L.             | * <i>Helianthus annuus</i> , L.            |
| * <i>A. blitoides</i> , Wats.              | † <i>H. petiolaris</i> , Nutt.             |
| * <i>Chenopodium glaucum</i> , L.          | † <i>Iva xanthiifolia</i> , Nutt.          |
| * <i>Cleome integrifolia</i> , T. & G.     | * <i>Krinitzchia crassise-pala</i> , Gray. |
| <i>Draba nemosa</i> , L.                   | * <i>Lepidium apetalum</i> , Wild.         |
| * <i>Dracocephalum parviflorum</i> , Nutt. | † <i>Monolepis chenopodioides</i> , Moq.   |
| * <i>Echinosperrnum Redowskii</i> , Lehm.  | * <i>Plantago Patagonica</i> , Jacq.       |
| * <i>Euphorbia glyptosperma</i> , Engelm.  | † <i>Sisymbrium incisum</i> , Engelm.      |
| * <i>Franseria Hookeriana</i> , Nutt.      | * <i>Solanum triflorum</i> , Nutt.         |
| * <i>Ellisia Nyctelea</i> , L.             |  |

## II. BIENNIALS.

- |                                       |                                 |
|---------------------------------------|---------------------------------|
| <i>Cnicus eriocephalus</i> , Gray.    | * <i>Hordeum jubatum</i> , L.   |
| * <i>Gaura parviflora</i> , Dougl.    | † <i>Oenothera biennis</i> , L. |
| * <i>Grindelia squarrosa</i> , Dunal. |                                 |

## III. PERENNIALS.

†*Achillea Millefolium*, L.  
*Artemisia Ludoviciana*, Nutt.  
 \**Cnicus undulatus*, Gray.  
*Epilobium angustifolium*, L.  
*Gaura coccinea*, Nutt.  
*Glycyrrhiza lepidota*, Pursh.  
*Helianthus Nuttallii*, T. & G.  
*Iva axillaris*, Pursh.  
 \**Lactuca pulchella*, DC.

\**Lepachys columnaris*, T. & G.  
*Lupinus pusillus*, Pursh.  
*Lupinus sericeus*, Pursh.  
*Lygodesmia juncea*, Don.  
 \**Malvastrum coccineum*, Gray.  
*Platago Asiatica*, L.  
 \**Rumex salicifolius*, Weinm.  
 \**Verbena bracteosa*, Michx.

This would give the composition of our weed flora as

	Native.	Introduced.	Total
Annuals.....	19	66	85
Biennials.....	5	9	14
Perennials.....	17	16	35
	41	93	134

It thus appears that more than two-thirds of the weeds already noted in the state are of foreign origin and may be kept out of districts in which they are not already established, while, unless preventive measures are taken, the number of such introductions will be greatly increased.

The species enumerated below appear to be extending gradually westward from the Plains.

*Allionia nyctaginea*, Michx.  
*Amaranthus albus*, L.  
*A. blitoides*, Wats.  
*Cerastium nutans*, Raf.  
*Cleome integrifolia*, T. & G.  
*Cnicus undulatus*, Gray.  
*Echinosperrum Redowskii*, Lehm.  
*Euphorbia marginata*, Pursh.  
*Franseria Hookeriana*, Nutt.  
*Gaura parviflora*, Dougl.

*Grindelia squarrosa*, Dunal.  
*Helianthus annuus*, L.  
*Iva xanthiifolia*, Nutt.  
*Hordeum jubatum*, L.  
*Krinitzchia crassisejala*, Gray.  
*Lepachys columnaris*, T. & G.  
*Lepidium apetalum*, Willd.  
*Monolepis chenopodioides*, Moq.  
*Panicum capillare*, L.  
*Plantago Patagonica*, Jacq.  
*Solanum triflorum*, Nutt.

A few species are coming into the state from the Pacific coast:

*Chenopodium biennis*, Willd.  
*Chenopodium capitatum*, Wats.  
*Echinosperrum deflexum*, Lehm.  
*Epilobium paniculatum*, Nutt.  
*Madia glomerata*, Hook.

*Madia filipes*, Gray.  
*Matricaria discoides*, DC.  
*Rumex salicifolius*, Weinm.  
*Sisymbrium incisum*, Engelm.  
*Xanthium spinosum*, L.

The following, supposed to be natives of tropical America, are now common over much of the Eastern United States, and, with many of the weeds of the plains, are probably our inheritance from the prehistoric American civilizations.

*Amaranthus chlorostachys*, Willd.

*Erigeron Canadensis*, L.

*A. retroflexus*, L.

*Solanum rostratum*, Dunal.

*Ambrosia artemisiæfolia*, L.

*Xanthium Canadense*, Mill.

*A. trifida*, L.

All the other species enumerated in this paper, with two or three doubtful exceptions, are from the Old World and have reached us mainly from the Eastern States.

### THE ROOT SYSTEM.

The root system is of great importance as indicative of the life duration of a species and hence must be taken into account in fixing upon methods for weed extermination.

An *annual* plant germinates, bears fruit and perishes in a single season, while a *biennial* bears only a tuft of leaves the first year and fruits and dies the second. A *perennial* species lives and bears fruit for many years in succession. The roots of annuals are tender and of about the same size as the stem; biennials are usually tender and often thickened and fleshy, but are sometimes difficult to distinguish from annuals; otherwise than by observation, while a number of weeds appear to be either, as emergency requires. Perennials usually have thick, woody, deeply penetrating roots, or long underground stems, or tubers, which enable them to endure indefinitely. The weeds in cultivated ground are mostly rapid-growing annuals, or perennials with fleshy or tuberous roots or rootstocks; those of pastures and meadows are perennials almost exclusively and cannot withstand cultivation.

### CLASSIFICATION BY SITUATION.

Weeds may be grouped roughly by means of the localities they affect and the causes that make them objectionable.

I. WEEDS OF YARDS, WAYSIDES, AND WASTE PLACES.—These are often tall and unsightly or tend to spread to adjacent fields and gardens. They replace the native plants exterminated by the feet of man and the domestic animals and the wheels of vehicles.

Their seeds usually are spread by the mud of passage or by the wind. The following species may be enumerated as more or less common in these situations:

<i>Amaranthus albus</i> , L.....	"Tumble-Weed."
<i>A. blitoides</i> , Wats.....	"Pigweed-Purseley."
<i>Ambrosia trifida</i> , L.....	"Horseweed" (Eastern.)
<i>A. artemisiaefolia</i> , L.....	"Ragweed."
<i>Anthemis Cotula</i> , DC.....	"Dogfennel."
<i>Arctium Lappa</i> , L.....	"Burdock". (true), rare.
<i>Artemisia biennis</i> , Willd.....	"Wormwood."
<i>Atriplex patula hastata</i> , Gray.....	
<i>Arenaria serpyllifolia</i> , L.....	"Sandwort," rare.
<i>Brassica campestris</i> , L.....	"Kale." "Wild Mustard."
<i>Brassica nigra</i> , Koch.....	"Black Mustard;" a rare escape.
<i>Bromus racemosus</i> , L.....	
<i>B. tectorum</i> , L.....	
<i>Capsella Bursa-pastoris</i> , Moench.....	"Shepherd's Purse."
<i>Chenopodium album</i> , L.....	"Pigweed," common.
<i>C. Botrys</i> , L.....	"Jerusalem Oak," common where introduced
<i>C. capitatum</i> , Wats.....	"Red Pigweed," westward.
<i>C. hybridum</i> , L.....	"Maple-leaved Goosefoot."
<i>Cleome integrifolia</i> , Torr. & Gray.....	"Indian Pink," frequent in sandy soil.
<i>Cnicus arvensis</i> , Hoffm.....	"Canada Thistle," rare.
<i>C. lanceolatus</i> , Willd.....	"Scotch Bull Thistle."
<i>Echinosperrum deflexum Americanum</i> , Gray.....	"Beggar Ticks."
<i>E. Redowskii</i> , Lehm.....	"Tickseed."
<i>Ellisia Nyctelea</i> , L.....	
<i>Epilobium paniculatum</i> , Nutt.....	"Cottonweed."
<i>Erigeron Canadensis</i> , L.....	"Ragweed," rather infrequent.
<i>Euphorbia marginata</i> , Pursh.....	
<i>Franseria Hookerania</i> , Nutt.....	
<i>Helianthus annuus</i> , L.....	"Sunflower," common east of the Divide.
<i>Hordeum jubatum</i> , L.....	"Foxtail Grass," common.
<i>Iva xanthiifolia</i> , Nutt.....	"Horseweed," common.
<i>Lactuca Scariola</i> , L.....	"Prickly Lettuce."
<i>Lepidium apetalum</i> , Willd.....	"Birdseed," common.
<i>Madia glomerata</i> , Hook.....	"Tarweed."
<i>Marrubium vulgare</i> , L.....	"Horehound," infrequent.
<i>Matricaria discoidea</i> , DC.....	"Rayless Dogfennel," frequent.
<i>Monolepsis chenopodioides</i> , Moq.....	"Poverty Weed," common.
<i>Panicum capillare</i> , L.....	"Tumble-grass," frequent eastward.
<i>Plantago major</i> , L.....	"Plantain," infrequent.
<i>Polygonum aviculare</i> , L.....	"Knotgrass," common.

<i>Rumex crispus</i> , L.....	"Curly-leaved Dock," frequent.
<i>Rumex salicifolius</i> , Weinm.....	"Willow-leaved Dock."
<i>Salsola Kali</i> Tragus, Moq.....	"Russian Thistle."
<i>Sisymbrium incisum</i> , Engelm.....	"Tansy Mustard."
<i>Sisymbrium officinale</i> , Scop.....	"Hedge Mustard," infrequent.
<i>Solanum rostratum</i> , Dunal.....	"Buffalo Bur," infrequent.
<i>S. triflorum</i> , Nutt.....	"Wild Potato," common.
<i>Taraxacum officinale</i> , Weber.....	"Dandelion," common.
<i>Tragopogon porrifolius</i> , L.....	"Salsify," infrequent.
<i>Urtica gracilis</i> , Ait.....	"Stinging Nettle," frequent.
<i>Verbascum Thapsus</i> , L.....	"Mullein," in some localities common.
<i>Verbena bracteosa</i> , Michx.....	"Vervain."
<i>Xanthium Canadense</i> , Mill.....	"Cuckle-bur," infrequent.

II. WEEDS OF LAWNS, MEADOWS AND PASTURES.—These are usually perennial and are obnoxious because they are not only unsightly, but tend to crowd out the more desirable grasses. The seeds of many of these are wind disseminated; some appear to come in with the seed sown. In hay fields they materially injure the quality and selling power of the product.

<i>Achillea Millefolium</i> , L.....	"Millfoil, Yarrow." Common.
<i>Cnicus eriocephalus</i> , Gray.....	In mountain meadows.
<i>Cnicus undulatus</i> , Gray.....	"Thistle." Common.
<i>Grindelia squarrosa</i> , Dunal.....	"Rosin Weed." Common in pastures.
<i>Hordeum jubatum</i> , L.....	"Foxtail Grass." Common in low ground.
<i>Lepachys columnaris</i> , T. & G.....	"Coneflower," pastures.
<i>Plantago Patagonica gnaphalioides</i> , Gray.....	"Woolly Plantain." Pastures.
<i>P. major</i> , L.....	"Plantain." Troublesome in lawns.
<i>Rumex Acetosella</i> , L.....	"Sheep-sorrel."
<i>Taraxacum officinale</i> , Weber.....	"Dandelion." Frequent in all situations.

III. WEEDS OF GARDENS AND CULTIVATED GROUNDS.—These are the pests against which the farmers wage incessant warfare, as they tend to crowd out the cultivated plants. By far the greater part of these are annuals, probably importations, recent or remote. Seven are perennials with long creeping root-stocks, all native species (the Canada thistle excepted), while two are often biennials.

#### A. ANNUALS.

<i>Amaranthus albus</i> , L.....	"Tumble-weed." Abundant in loose soil.
<i>A. blitoides</i> , Wats.....	"Pigweed-Pursley." Common with the last.

- A. retrofractus, L....."Careless Weed." Common in gardens and rich soil.
- A. chlorostachys, Willd.....Much less frequent; confused with the last.
- Artemisia biennis, Willd....."Wormwood." Frequent in many places.
- Capsella Bursa-pastoris, Moench....."Shepherd's Purse." Common in gardens.
- Chenopodium album, L....."Pigweed." Common in cultivated ground.
- C. glaucum, L.....A weed not infrequent in gardens.
- Cnicus undulatus, Gray....."Thistle."
- Draba nemorosa, L.....Common.
- Erigeron Canadensis, L....."Ragweed." frequent.
- Helianthus annuus, L....."Sunflower." One of the worst weeds in the state.
- Iva xanthiifolia, Nutt....."Horseweed." Common east of the Divide.
- Lepidium apetalum, Willd....."Birdseed."
- Monolepis chenopodioides, Moq....."Poverty Weed."
- Polygonum Convolvulus, L....."Wild Buckwheat."
- Solanum rostratum, Dunal....."Buffalo-bur."
- Solanum triflorum, Nutt. ...."Wild Potato."
- Sonchus asper, Vill....."Sow Thistle."

## B. PERENNIALS.

- Artemisia Ludoviciana, Nutt....."White Sage."
- Cnicus arvensis, Hoffm....."Canada Thistle."
- Epilobium augustifolium, L....."Iron-weed." In mountain regions.
- Glycyrrhiza lepidota, Pursh....."Wild Liquorice." In low ground.
- Lactuca pulchella, DC....."Milk-weed."
- Lupinus sericeus, Pursh....."Lupine." Persistent in new ground.
- L. pusillus, Pursh....."Little Lupine." Root tuberous.
- Lygodesmia juncea, Don....."Wild-asparagus." Plains.

IV. WEEDS OF THE GRAIN-FIELDS.—Mostly annuals fruiting at the same time as the grain; the thistle is a biennial and sheep-sorrel and Gaura are perennial with creeping root-stocks. These from their size, rapidity of growth, or undue multiplication tend to choke out the grain in which they grow and are difficult to repress on account of the fact that, after seeding, about the only way to get at them is by hand-pulling, a slow and expensive process.

- Avena fatua, L....."Wild Oats." Common all over the state.
- Brassica Sinapistrum, Boiss....."Wild Mustard." Very bad in many localities.
- Bromus secalinus, L....."Cheat." Troublesome in some places.
- Camelina sativa, Crantz....."False Flax."
- Cleome integrifolia, Torr. & Gray....."Indian Pink."

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<i>Euphorbia glyptosperma</i> , Engelm.....	"Spurge."
<i>Gaura coccinea</i> , Nutt.....	
<i>Helianthus annuus</i> , L.....	"Sunflower."
<i>Iva xanthiifolia</i> , Nutt.....	"Horseweed."
<i>Lactuca pulchella</i> , DC.....	"Milkweed."
<i>Rumex Acetosella</i> , L.....	"Sheep Sorrel."
<i>Polygonum Convolvulus</i> , L.....	"Wild Buckwheat."
<i>Saponaria Vaccaria</i> , L.....	"Cockle."

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## II. PRACTICAL CONSIDERATIONS.

### METHOD OF ERADICATION.

1. CROP ROTATION—It will be seen from the foregoing lists that our weeds, troublesome in cultivation, fall naturally into three groups: (1) weeds of grain fields, (2) of meadows and (3) of cultivated ground and that our yards, roadsides and waste places are the chief sources of local infection. The natural method for the suppression of weeds then must be by crop rotation, as the growth of one kind of crops tends to restrain or destroy the weeds peculiar to the other two groups. Therefore, when our grain fields become foul with the sunflower or wild oats, they should be put in timothy, alfalfa or clover till the weeds have been crowded out; or the land may be cultivated in some root crop like potatoes, rutabagas, &c., and the weeds destroyed by frequent cultivation. Unfortunately, here in Montana, the climatic conditions limit this crop rotation almost to cereals and hay-lands, as maize can be grown profitably in but few parts of the state and root crops and garden truck can not be planted over any great area, on account of the expense and labor involved and the certainty of swamping the market.

2. **SUMMER FALLOW.**—Where it is desired to grow a grain crop as continuously as possible, it is hardly profitable to seed down in timothy, alfalfa or clover for a single year, and, as extensive cultivated crops, such as are grown in the Mississippi valley, are not here feasible for the reasons stated, in many parts of the state a system of summer fallow has been adopted, which consists usually in plowing under the weeds late in May or June before they have matured and then going over the soil once or twice afterwards with a disk or cultivator to prevent the new growth attaining any size. This effectually reduces the growth of the annual weeds so troublesome to grains and materially increases the fertility of the soil, but the loss of income from the fallowed land and the expense of cultivation, far offset any advantages thus derived, while, unless the land is disked after plowing, it is often worse seeded in weeds than before. It is much more profitable either to seed down foul wheat lands in some hay crop or in grain suitable for pasturage and thus secure some return from the land while the weeds are being killed.

3. **PASTURAGE.** There are some weeds like the sunflower, wild oats, and wild mustard, which are very difficult to clear out of land, when once they have a good foothold. For such weeds, and other of like nature, a very effective and profitable method of eradication is to sow the land down in some grain suitable for pasturage, such as rye or oats, or in clover or mixed grains, and to keep this closely cropped by sheep, so that no weeds that come up will have any chance to mature seed. Two or three years of successive pasturage in this manner should effectually clean the worst infested lands. Other kinds of stock will do, but they are more prone to exercise selection and permit the growth of the less edible varieties. Sheep clean off all alike.

4. **SPECIAL METHODS.**—In some cases special methods may be employed with advantage. Hand-pulling is frequently possible in small fields or patches of grain infested with the sunflower, wild mustard, tumbling mustard, etc. This may be done by boys under competent supervision, and is best undertaken when the weeds first come well into bloom and before they have matured any seed. The bright yellow flowers serve as guides to the location of each individual and their absence clearly marks the strip

cleared. The work should not be left till the seeds begin to mature, else it will be necessary to remove the plants pulled to prevent them from re-seeding the ground cleared. This method is slow and expensive, especially here in Montana where labor is such a desideratum, and it can rarely be employed with economy.

In a few instances hand weeding is practically the only method available. This will apply particularly to weeds affecting lawns and meadows. The broad-leaf plainein can only be dug up one plant at a time, and this is also true of the dandelion and thistles, but with the last two a chisel-like instrument ("spud") with a four foot handle may be employed to cut them off just below the crown of leaves and is usually found effective.

There are a few species of weeds which are particularly difficult of extermination on account of the spread of underground stems. A few of our native species exhibit this tendency to a greater or less extent, such as the Poverty Weed (*Iva axillaris*), the Wild Liquorice (*Glycyrrhiza lepidota*), the Milk-weed (*Lactuca pulchella*), the Wild Asparagus (*Lygodesmia juncea*), the Iron-weed (*Epilobium angustifolium*), and the Lupine (*Lupinus sericus*), but these usually disappear after a few years cultivation and persist only in specially favored localities, where they may be treated like the next. But it is from a few foreign introductions that the chief trouble arises and these should be exterminated before they have become firmly established. The Canada Thistle is the worst and a law has been enacted to enforce its destruction in the state. It is established in many places along the railroads and is frequently imported with garden seed. It is found only in small patches and appears to show little disposition to spread by seed in this state. The most effective method to get rid of it is probably to dig it up, removing every particle of the root-stocks and then await growth to indicate the location of any root remnants in the soil. Its growth can be restricted by keeping it cut down, but this will scarcely exterminate it. It can be smothered out by building straw or haystacks over the spots affected, or by covering with manure dumps, and it may often be killed by plentifully sprinkling salt or kerosene over the freshly cut stumps. Sodium arsenite is more effective, but also more expensive.

The wild Morning-glory (*Convolvulus arvensis*) and the Sheep-

sorrel (*Rumex Acetosella*) are nearly as difficult to eradicate and much worse to spread than the Canada thistle, but fortunately they have as yet appeared in but few localities in the state. They should be treated in much the same way as the Canada thistle above. For lawn weeds which tend to spread and crowd out the grasses, such as dandelion, plantain, chickweed (*Cerastium vulgare*), rosin-weed (*Grindelia squarrosa*) and others of like nature there is nothing we can do more than to dig them up by hand, or treat them with chemicals, which also will kill the grass around. The process is slow but the areas affected are usually not large. Walks and driveways can be kept clear by the aid of salt, kerosene, arsenite of soda, or some of the various chemicals sold by seedsmen. Much time and labor can be saved, if it be remembered that the streets, roadsides and waste places are the natural storehouses for the growth and propagation of weeds and that these places must be kept clear, or at least the weeds must be kept from seeding in them, if the yards, gardens and fields adjacent are to be free from these pests.

The Russian thistle, of which so much has been said and written, does not appear to exhibit such dangerous characteristics in this state. I have found it nowhere in any abundance except in the Milk River and Yellowstone valleys, and there as well as in all other places observed it is confined to the railway grades and waste places about the towns. It makes no headway against the native vegetation and has not yet, in any case noted, invaded cultivated land. Nevertheless, its wide advertisement as a most dangerous pest must be based upon its tendency to invade grain-fields and cultivated ground and it is comparatively little trouble to prevent it from securing a footing in any locality, if taken when it first appears and every plant be uprooted, piled and burned. It is possible that it may yet prove a valuable forage plant for the arid regions, and instead of a most dangerous, immigrant, it may prove a valuable addition to our native vegetation.

The Scotch bull thistle is not nearly as dangerous as the dandelion and sheep-sorrel, the wild oats, the wild mustard, tumbling mustard and the sunflower. It is very rare in the state, occurring mostly about railway stations and towns, in no considerable quantity except in the Flathead valley in the vicinity of Demers-

ville, where it has proven a dangerous pest. It should be dug up or cut off below the crown of the root before it blooms. It is not a perennial like the Canada thistle and only needs to be kept down for a year or two and prevented from seeding. It should not be allowed to become established in any locality and any person permitting it to grow on his land should be prosecuted under the law now in force.

A great difficulty in the extermination of weeds is the fact that the seeds of many species will lie in the soil for several years without losing their vitality and when turned up to the surface will germinate and produce a new crop of weeds in ground which is considered cleared. It is for this reason that several years of diligent culture is necessary before a field can be cleared of such weeds as the sunflower, wild oats and wild mustard and it is for this reason that summer fallow, unless followed by cultivation, will result in seeding the field with weeds more than before. A field can not be cleared of noxious weeds until all the seeds can be caused to germinate and then killed.

There is no question but that the injury done the growing crops in this state by the growth of weeds amounts to many hundred thousand dollars every year and yet there is no systematic method devised for their eradication. Each man tills his own fields with little regard to the growth and distribution of weeds from infected localities; and no combined attempt is made to stamp out the pests in such affected areas. If we treated contagious diseases it this way, it would be utterly impossible to stay the deadly epidemics. Isolation and united effort is made against such diseases in every community, and a similar effort against weeds would certainly be successful in this state, where the agricultural communities are naturally more or less isolated from each other.

The only feasible method then for combatting weeds in Montana where few of the more dangerous and troublesome species have yet more than secured a foothold, is by the organization of the farmers into districts designated by the valley or irrigation system and the appointment or election of a competent weed inspector for each district, whose duty it shall be to keep a lookout for the appearance of any new or dangerous weeds in his district and to cause the eradication of such pests as may already be es-

tablished, and this inspector shall have similar powers to road supervisors to call for a certain amount of aid from each farmer to be used in the common interest of stamping out these pests from infected localities, or to compel individuals to clear their lands of such pests.

It would thus be possible to hold one man responsible for keeping down these noxious weeds, while now the responsibility is fixed upon no one and the interests involved are certainly as great, if not greater, than in the maintenance of a good road system. It should also be made the duty of the road supervisors to keep the weeds cut or plowed under along the different public highways within their jurisdiction. Unless some effort of this kind is soon made, the labor of the farmer will be greatly increased.

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### THE WEED LAW NOW IN FORCE IN MONTANA.

[PENAL CODE, APPROVED MARCH 18, 1895.]

“§1197. Be it enacted that the weeds known as the Canada thistle, the Scotch bull thistle and the Russian thistle are hereby declared to be a common nuisance for all the purposes of this Act.

§1198. Any person or persons owning any lands within this State, or occupying or having control of any lands, whether within the plat of towns, villages or cities, or otherwise, within this State, knowingly permitting or suffering any Canada, Scotch bull or Russian thistle or thistles to go to seed upon any land or lands thus owned, occupied or under control of such person or persons shall be deemed guilty of supporting and maintaining a common nuisance, and upon conviction thereof in any court of competent jurisdiction, of the offense, shall be punished by a fine not exceeding fifty nor less than five dollars.

§1199. In case any person or persons, railroad or other corporation, owning or occupying any lands within this State, under his or her or their control, as the case may be, shall refuse or neg-

lect to destroy any Canada, Scotch bull or Russian thistle or thistles growing or standing upon any land or lands so owned, occupied or controlled, on or before the fifteenth day of August, it shall be the duty of the county commissioners, road supervisors, or other person or persons having control of the public highways, streets or alleys where any such thistle or thistles may be found growing or standing, to immediately destroy or cause the same to be destroyed, and pay therefor at the same rate that is paid for road labor; and every supervisor or other person hereinbefore authorized to destroy said thistles shall keep a correct account of all moneys paid out for that purpose, and charge the same to the person or persons or corporation owning, occupying or controlling the land or lands upon which such thistle or thistles were destroyed, and the person or persons or corporation owning, occupying or having control of such lands shall be liable in a civil action for the amount so charged against them and costs of suit;

*Provided* that if any supervisor or other person having, under authority of this Act, destroyed any of the said thistles, and is unable to find the owner of the land, or is unable to collect such money, the same shall be paid by the authorities of the town, village, city or county where such thistles were destroyed; *and provided further*, that in case any railroad company becomes chargeable under the provisions of this Section, the supervisors of the township where same has become chargeable may certify to the same to the county attorney of their county, whose duty it shall be to bring and prosecute a civil action against the railroad company for the amount so charged and costs of suit aforesaid.

§1200. It is hereby made the duty of every person having knowledge of any Canada, Scotch bull and Russian thistle or thistles growing or standing upon the lands of another to immediately destroy the same, or give the person owning or occupying such lands immediate notice thereof."

## III. ANNOTATED LIST OF MONTANA WEEDS.

In order to note the introduction and spread of weeds in this state, and to give the farmer some idea as to the names of the weeds troublesome in any particular locality and facilitate their destruction, if dangerous, the following enumeration of the known weeds of Montana, with brief popular descriptions of the more troublesome species and notes of their origin, occurrence and dissemination is appended. In case of doubt, specimens of any weed with flower or fruit and leaves should be sent this Station for determination.

In a general work of the nature of this bulletin, it seems desirable, in the main, to use the older, more conservative nomenclature and to adopt the wider limitation of species, not necessarily because they are better or more accurate, but because they are more easily understood by the ordinary reader and are more readily found in the usual works of reference. For the same reason technical terms have been avoided as far as possible, and the popular names of plants have been employed wherever it could be done without ambiguity. Yet, as common names are frequently used here, for two or more very different species, or for different plants in other sections of the Union, as in the case of the pursely, cucklebur, horseweed, ragweed, milkweed, ironweed, povertyweed, &c., it is necessary to make the scientific name the basis of classification and description. Hence the plants hereafter enumerated are arranged alphabetically according to their scientific names, but the index of popular names appended will enable these to be used with equal facility.

A few terms need explanation. Flowers and fruit are arranged in a *spike* when they form a close slender column like those of the plaitain and timothy; they form a *panicle* when they are scattered on slender stalks, like the oat, and they are called a *head* when they are aggregated in a dense cluster, as in the case of the clover and the sunflower.

In the list below the weeds most troublesome in the state are printed in **black letter** and the rare introductions are starred (\*).

**1. ACHILLEA MILLEFOLIUM L. WILD TANŸY; MILFOIL.**

A perennial plant about two feet high with finely divided leaves and white flowers in a level-topped cluster. Frequent in pastures and meadows, where its bitter herbage makes it distasteful to stock.

**2. AGROSTEMMA GITHAGO, L. CORN COCKLE.**

A purple-flowered annual occasional in grain fields, but hardly troublesome here, as it is in the East. Noted in but few localities. It has narrow leaves and fewer and more scattered flowers than is the case with the ordinary cockle (*Saponaria Vaccaria*) and is silky hairy throughout.

**3. ALLIONIA NYCTAGINEA, Michx.**

A tall (2 to 4 feet high), smooth, much-branched perennial with heart-shaped opposite leaves and clustered purplish flowers. Occurs as a weed in gardens in the extreme eastern part of the state (Calais and Wibaux) and promises to spread westward.

**4. AMARANTHUS ALBUS, L.****TUMBLE-WEED.**

A widely-spreading annual weed, common in loose or cultivated ground. It begins blooming in early spring and produces seed all the season. It is killed down by the first heavy frost and the large globular mass breaks off from the root and is driven about by the wind, scattering its seeds throughout its course. Apparently native east of the Divide. Hybridizes with the next. [Fig. 1].



Fig. 1. *Amaranthus albus*, L.  
Branch  $\frac{1}{2}$  natural size.

**5. AMARANTHUS BLITOIDES, Wats. PIGWEED-PURSELEY.**

A prostrate-growing, reddish annual, closely related to the preceding and much resembling the eastern "purseley" (*Portulaca oleracea*, L.) Common in waste places and roadsides east of the Divide and not infrequent as a weed in cultivated ground. Forms mats sometimes three feet in diameter; apparently native.

**6. \*AMARANTHUS CHLOROSTACHYS, Willd. PIGWEED.**

Closely resembling the next in habit and appearance and popularly confused with it, but its fruiting spikes are long and slender and it is much more rare in gardens and waste places. At Columbia Falls and Troy; here apparently coming in from the West.

**7. AMARANTHUS RETROFLEXUS, L. PIGWEED; CARELESS WEED.**

A fleshy annual common in our gardens and imported from the East in garden seed; shows little tendency to spread to fields except in rich and moist situations. These four species of amaranth are easily uprooted and should not be allowed to seed in our gardens. They should be piled, dried and burned to prevent the seeds matured from re-seeding the ground from which they have just been removed.

**8. AMBROSIA ARTEMISIÆFOLIA, L. RAGWEED; HOGWEED.**

An annual weed, one or two feet high, with opposite many-divided leaves and slender, green-flowered terminal spikelets. This is now coming in from the East along the railways. Frequent on the Great Northern from Havre eastward and occasional as far west as Kalispell. Often abundant in waste places, but with little disposition to take to fields and gardens.

**9. AMBROSIA PSYLOSTACHYA, DC. CREEPING RAGWEED.**

Occurs occasionally in the eastern part of the state, but has not yet been found very troublesome. It is very similar to the one above, but has long perennial rootstocks which make it difficult to eradicate.

10. *AMBROSIA TRIFIDA*, L. HORSEWEED; TALL RAGWEED.

A large annual with opposite three-lobed leaves and flowers very similar to the two above. It is here rarely more than two or three feet high, and is found occasionally with leaves entire. Like *A. artemisiæfolia* it is coming in from the Mississippi valley along the railways and is found principally in waste land about the stations, but in low situations is spreading to adjacent fields and gardens. Extends as far west as Havre and Savoy on the Great Northern and to Bozeman on the Northern Pacific. Infrequent except eastward. Seeds disseminated by water and in mud. [Fig. 2.]

Fig. 2. *Ambrosia trifida*, L.11. *ANTHEMIS COTULA*. DC.

DOG FENNEL; MAYWEED.

An annual ill-scented weed about a foot high, with a level-topped mass of white-rayed flowers; leaves alternate and finely divided. Not infrequent in waste places in nearly every part of the state and shows some disposition to spread and become troublesome as it does in the more humid climate of the eastern states.

12. \**ARCTIUM LAPPA*, L. BURDOCK.

A coarse biennial about three feet high, with large leaves and purple flowered heads disposed in a many-branched terminal panicle each surrounded with a bur-like involucre. A European introduction common in the eastern states, but noted here only at Libby, Thompson Falls, Plains and Big Timber, along roadsides and

in waste places, where it shows a strong disposition to spread and become troublesome to the sheep industry.

13. *\*ARENARIA SERPYLLIFOLIA*, L.

A small, inconspicuous annual two or three inches high, or prostrate, of European origin, well established about the streets and waste places at Columbia Falls, but not otherwise noted in the state.

14. *ARTEMISIA BIENNIS*, Willd. WORMWOOD; IRONWEED.

An annual or biennial coming in from the west, two or three feet high, with a slender, reddish stem, finely divided leaves and a narrow terminal spike-like panicle of inconspicuous flowers. Becoming common in streets and waste places about the larger towns and thence spreading to the highways and neighboring fields, where it is beginning to be a troublesome pest.

15. *ARTEMISIA LUDOVICIANA*, Nutt. WHITE SAGE.

A native perennial sage with long creeping rootstocks which tend to persist in new ground and meadows and is often difficult to eradicate.

16. *\*ATRIPLEX HORTENSIS*, L. ORACHE.

Escaped from cultivation, particularly the ornamental variety *atrosanguinea*, Hort. Not infrequent in yards and waste places about Helena and Bozeman, but not likely to become troublesome. An annual much resembling its relative the Lamb's-quarter.

17. *ATRIPLEX PATULA HASTATA*, Gray.

An annual much resembling and often confused with Lamb's Quarter; occurring along streets and in waste places; apparently introduced from the East. Occurs occasionally in nearly every part of the state but is rarely troublesome in cultivated ground.

18. *AVENA FATUA*, L. WILD OATS.

This is one of the most common, if not the worst weed in the state. Introduced from the Old World, but now common throughout most parts of arid America where oats have been cultivated. The wild oat differs from the cultivated variety in its usual ranker growth, deeper color of the foliage, more diffuse panicle, earlier



Fig. 3. *Avena fatua*, L. Fruit, natural size.

ripening and prompt shelling of the fruit, its black hull (flowering glume), hairy at base and with a twisted awn and in its smaller and lighter seed. Its fecundity, rapid growth and self-seeding qualities soon enable it to take a field sown continuously in any kind of grain and the persistent vitality of its seed in the soil makes it difficult to eradicate. It can best be combatted by sowing down infested fields in clover, timothy or alfalfa, or by close pasturage by sheep for several years of such fields, planted in some annual grain suitable for forage. There is a general belief among farmers that the wild oat often originates as a degenerate form of the cultivated variety with which it seems to intergrade, and, while it is propagated in general from its own seed, its general occurrence and abundance in fields sown in oats throughout the arid region seems to favor the idea of such reversion. Moreover, the cultivated oat is supposed to have been derived from the wild species, and several authenticated instances are known of the production of the tame varieties from the wild form by cultivation and reversion under suitable climatic conditions is much more probable, as is certainly the case with many other cultivated plants, such as the radish, carrot, turnip, mustard and parsnip, which in many places readily revert to the wild form and become troublesome weeds. [Fig. 3.]

19. **BRASSICA CAMPESTRIS** L. KALE; WILD TURNIP.

An annual closely resembling and usually confused with the wild mustard (*Brassica Sinapistrum*, Boiss.), but is smooth throughout and is rarely so common or troublesome as the latter species, though occasionally found in grain fields and waste places. Its smooth, bluish stem and upper leaves, sessile and clasping, easily distinguish it from the two below.

20. \***BRASSICA NIGRA**, Koch. BLACK MUSTARD.

An occasional escape from gardens, but nowhere troublesome or difficult to restrain. Rarely persistent.

**21. BRASSICA SINAPISTRUM, Boiss. WILD MUSTARD; CHARLOCK.**

Resembling the *B. Campestris* above, but is more or less hairy throughout. One of the worst weeds of the state, fairly taking many of the grain fields in low land. Should be combatted like the wild oat and the sunflower. Hand pulling may be employed when it occurs only in small patches. Every effort should be made to prevent its introduction into a community and combined action should be taken to clear infested fields, as the seeds appear to be spread largely by irrigation. [Fig. 4.]

**22. BROMUS RACEMOSUS, L.**

An annual Brome-grass not infrequent as a weed in fields and waste places; commonly confused with the next, which it closely resembles.

**23. BROMUS SECALINUS, L.**

CHEAT; CHES.

Differs from the last in its more diffuse panicle and its larger and flatter spikelets. Not rare in agricultural districts of the state and often a very bad weed in grain fields in the Flat-head valley.

**24. \*BROMUS TECTORUM, L. DOWNY BROME-GRASS.**

A small annual grass with long-awned pendulous spikes well established at Columbia Falls and Missoula, in streets and waste places and promises to spread into other parts of the state. Introduced from Europe.

**25. CAMELINA SATIVA, Crantz. FALSE FLAX.**

An annual with light yellow flowers and a pear-shaped pod of the Mustard family and resembling somewhat the cultivated flax. A frequent and occasionally troublesome weed in grain fields throughout the state. Usually imported in the grain seed sown.

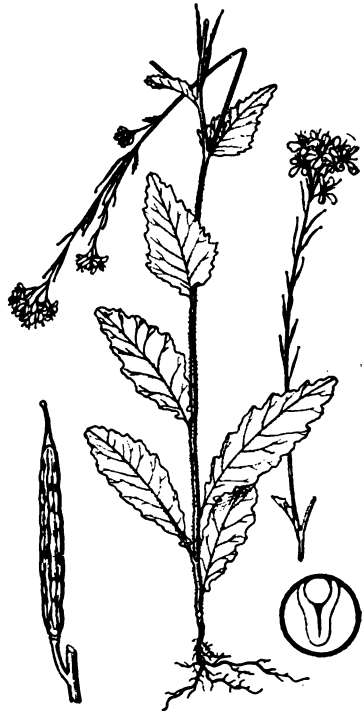


Fig. 4. *Brassica Sinapistrum*, Boiss,  $\frac{1}{4}$  natural size.

26. **CAPSELLA BURSA-PASTORIS**, Moench. SHEPHERD'S PURSE.

A common annual of yards, gardens and waste places. Blooms throughout the season. A foot or two high with white flowers and a triangular pod. A European introduction. Seeds develop a mucilaginous coat when wet and thus facilitate their dispersion.

27. **\*CERASTIUM NUTANS**, Raf.

A small inconspicuous chickweed with sticky foliage and curved pods notched at the orifice. Occasionally introduced from the East. In waste places infrequent.

28. **\*CERASTIUM VULGATUM**, L. MOUSE-EAR CHICKWEED.

Found very troublesome in lawns at Kalispell, where it forms patches and crowds out the grass and its perennial habit makes it difficult to exterminate, except by digging up and removing every plant. Also in waste places at Thompson Falls and Borax; coming in from the West.

29. **CHENOPODIUM ALBUM**, L.

LAMB'S QUARTER.

A common and troublesome annual in waste places and cultivated ground in nearly every part of the state. It fairly takes uncultivated fallow land in many localities. An Old World species. [Fig. 5]

30. **\*CHENOPODIUM BOTRYS**, L.

JERUSALEM OAK.

A bitter, ill-smelling annual from Europe locally established in waste places at various points in the state, and seems well adapted to our climate. Resembling the preceding species in size and appearance, but the leaves are more deeply lobed.



Fig. 5. *Chenopodium Album*, L.  $\frac{1}{8}$  nat. size.

## 31. CHENOPODIUM CAPITATUM, Wats. STRAWBERRY

BLITE. RED PIGWEED.

An annual weed in yards and waste places coming from the west along the railways; rare east of the Divide. Somewhat like the Lamb's Quarter, but the fruit is in red globular clusters resembling the strawberry.

## 32. CHENOPODIUM GLAUCUM, L. OAK-LEAVED GOOSEFOOT.

A prostrate or spreading annual much resembling the Poverty-weed (*Monolepis chenopodioides*), frequent in low grounds by roadsides, in alkali places and occasionally troublesome in gardens and cultivated ground. Possibly native here, although it has the habit of a true weed.

## 33. CHENOPODIUM HYBRIDUM, L. MAPLE-LEAVED GOOSE-

FOOT.

Another of the introduced Pigweeds, two or three feet high and with a widely spreading panicle of fruit, found occasionally in waste places about the towns along the railroads. Its leaves have little resemblance to those of our native maple. It is probably truly indigenous nowhere in America.

## 34. \*CHRYSANthemum LEUCANTHEMUM, L.

OX-EYED DAISY.

A European perennial found troublesome in the Eastern states. Apparently persistent in meadows here in a few isolated localities in small numbers, and showing no disposition to spread. Imported in grass seed from the East.

## 35. \*CICHORIUM INTYBUS, L. CHICORY.

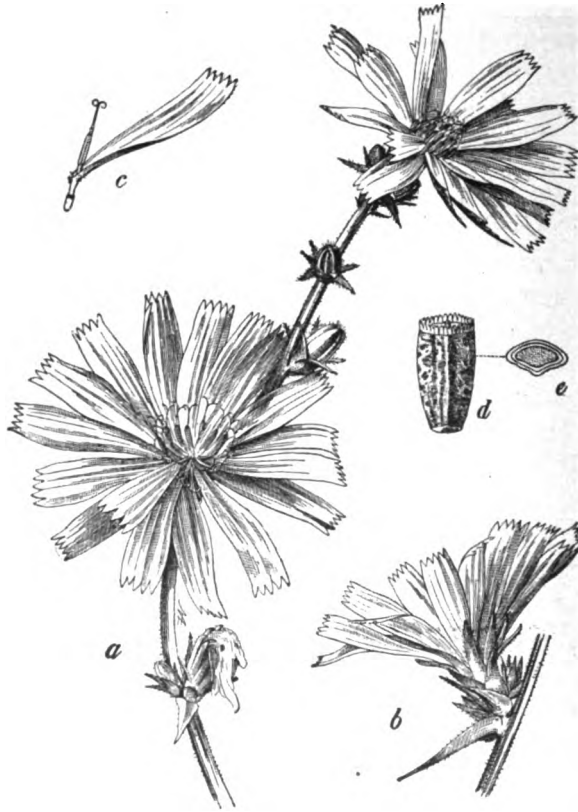


Fig. 6. *Cichorium Intybus*, L. Flower natural size.

A tall, widely branching European perennial with large blue flowers which close in the afternoon, related to and somewhat resembling the lettuce. A few specimens seen near Holt, in the Flat-head region; but observed nowhere else in the state. This weed is adapted to growth in dry situations and should not be allowed to become established in the state, lest it become a dangerous pest. [Fig. 6.]

**36. CLEOME INTEGRIFOLIA, Torr & Gray.**

INDIAN PINK; STINKWEED.

A native annual about two feet high with 3-foliate leaves and pink flowers, often troublesome in sandy soil. Frequent in grain fields and waste places east of the Divide and now spreading westward along the railways, where it threatens to become a bad weed.

**37. CNICUS ARVENSIS, Hoffm**

CANADA THISTLE.

A perennial European species with long creeping rootstocks most difficult to extirpate. Very similar to our native thistles, but the heads are much smaller and the plants tend to grow in clumps or patches, never scattered. Infrequent as yet in the state but becoming established along railroads and in waste places. Occurs at Helena, Bozeman, Libby, Craig and Demersville. Can be eradicated only by persistent digging, by smothering with straw, manure heaps, &c., or by choking out with a rank growth of clover. Attack on first appearance and do not permit it to become established. One of the three plants outlawed in this state. [Fig. 7.]



Fig. 7. a. *Cnicus arvensis*, Hoffm. Plant one-fifth.

### 38. *CNICUS ERIOCEPHALUS*, Gray. MOUNTAIN THISTLE.

A tall unbranched thistle with a mass of heads aggregated at the top of a thick, hollow, leafy, stalk, frequent in mountain meadows and pastures above 5,000 feet altitude. Rarely so abundant as to be troublesome.



Fig. 7. b. *Cnicus arvensis*, Hoffm. Leaf and head about natural size;

### 39. *CNICUS LANCEOLATUS*, Willd. SCOTCH BULL THISTLE.

The second outlawed weed of the state. A European biennial sparsely introduced along the railroads of the state, but nowhere observed to be troublesome except in the Flathead valley about Demersville. It is easily destroyed by digging up the plants before they bloom and

should not be allowed to secure a foothold. The plant is very similar to our native thistle described below, but has much less of the cottony tomentum on the under side of the leaves and the leaves and heads are exceedingly prickly with long yellow spines. [Fig. 8.]

### 40. *CNICUS UNDULATUS*, Gray. FIELD THISTLE.

The common thistle of the plains and valleys throughout the state and troublesome in many places, particularly in fallow land, old fields, pastures and meadows, replacing *C. eriocephalus* below 5,000 feet; biennial, or sometimes apparently perennial with deeply penetrating roots. A tall, branched thistle with scattered heads and leaves covered with a dense cottony tomentum.

## 41. \*CONVOLVULUS ARVENSIS, L. WILD MORNING-GLORY.

A European perennial vine similar to the cultivated morning-glory, but with small white flowers; occasionally established in

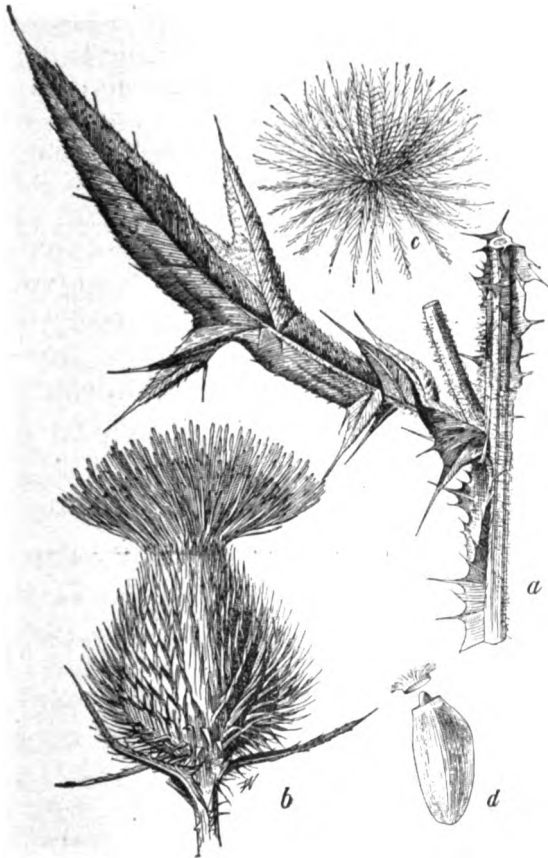


Fig. 8. *Cnicus lanceolatus*, Willd. Leaf and head natural size.

gardens and waste places; quite as difficult to exterminate as the Canada thistle and should be treated like it. Noted at Manhattan, Helena, Missoula, Flathead Lake, Kalispell, Bozeman and Crow Agency.

42. \**CUSCUTA EPITHYMUM*, Murr. ALFALFA DODDER.

Specimens of this species have come in from Livingston reported as troublesome in alfalfa fields. It is a golden yellow parasitic vine on alfalfa and the clovers; imported from Europe, where it is often a most pernicious weed. The infested spots should be mowed closely and the plants burned when dry; they should not be allowed to seed as it may be difficult to clear the field of the parasite. A native species of dodder (*Cuscuta arvensis*) also occurs sparingly on the clovers and alfalfa in this state, but is not apt to take the fields like the European species. [Fig. 9.]



Fig. 9. *Cuscuta Epithymum*, Murr.  
Plant natural size.

43. \**CYNOGLOSSUM OFFICINALE*, L. HOUND'S TONGUE.

A European biennial established in waste places at Big Timber.

44. *DRABA NEMOROSA*, L.  
FIELD DRABA.

A small annual of the Mustard family with yellow flowers and spreading pods, native of this region but inclined to multiply and grow rank in gardens and waste places.

45. *DRACOCEPHALUM PARVIFLORUM*, Nutt. DRAGON-HEAD.

An annual plant with dense square stems, opposite leaves and a terminal flowering spike inclined to frequent streets and waste places and occurs occasionally in cultivated ground. Doubtfully native here.

46. *ECHINOSPERMUM DEFLEXUM AMERICANUM*, Gray.  
BEGGAR TICK.

A slender annual one or two feet high, widely branching above and with small blue flowers and slender racemes of reflexed burs. At Deer Lodge and Helena (Rydberg), Box Elder Creek, on the Ft. Peck Reservation, Arlee, Plains and abundant and troublesome in the streets, highways and waste places about Kalispell, where it is rapidly spreading into the country adjacent. It threatens to become a bad pest throughout the state. Certainly an introduced species in this region and doubtfully native in America.

47. *ECHNOSPERMUM REDOWSKII*, Lehm.  
TICKSEED; BEGGAR TICKS.

A native annual resembling the preceding, but is smaller and has fewer erect fruit; common in loose soil about gopher hills, ant hills and prairie dog towns. A common weed in waste places throughout the Yellowstone region and in many places east of the Divide, but more rare westward. Occurs here as the varieties *occidentale*, Wats, and *cupulatum*, Gray, the latter much more rare.

48. *ELLISIA NYCTELEA*, L.

A small, diffusely branched, spreading annual with deeply lobed leaves and inconspicuous flowers. Not infrequent in low grain fields and waste places. Rarely abundant enough to be troublesome. Doubtfully native here.

49. *EPILOBIUM ANGUSTIFOLIUM*, L. IRONWEED; FIREWEED.

A tall, slender plant, about three feet high with a terminal raceme of large purple flowers, blooming about the first of August. Common in the foothills and mountains and the large perennial rootstock is often difficult to kill out in new ground.

50. *EPILOBIUM PANICULATUM*, Nutt. COTTON WEED.

A tall and very slender, smooth, widely branching annual with inconspicuous leaves and small red flowers, spreading eastward from the Pacific along the railways and principal lines of travel. Common along streets, highways and waste places in the western part of the state; the cottony seeds are distributed by the winds.

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**51. ERIGERON CANADENSIS, L.****RAGWEED; FIREWEED; HORSEWEED.**

A slender, hairy annual with narrow leaves and a large terminal broom of greenish flowers and cottony fruit imported from the eastern United States. Becoming frequent in waste places, gardens and grain fields, and a serious pest in the Flathead valley. Size varies from a few inches to several feet; seed spread by the wind.

**52. EUPHORBIA GLYPTOSPERMA, Engelm. CARPET WEED.**

A small, much-branching annual, lying flat on the ground and forming circular carpets a foot or more in diameter. Apparently native but frequent by roadsides and in grain fields and waste places; rarely troublesome.

**53. EUPHORBIA MARGINATA, Pursh. SNOW ON THE MOUNTAIN.**

An annual, one to two feet high, with milky juice and upper leaves white margined. In waste places and along railway grades from Miles City to Glendive. Coming in from the eastward. Reputed poisonous.

**54. FRANSERIA HOOKERIANA, Nutt.**

An annual weed very much like the Ragweed (*Ambrosia artemisiæfolia*), but with fruit of conspicuous burs. Frequent in sandy soil along highways and in streets and waste places in many parts of the state east of the Divide. Possibly native, although it has all the habits of an introduced weed.

**55. GAURA COCCINEA, Nutt. BUTTERFLY WEED.**

A native perennial with long, deeply penetrating rootstock, frequent in new ground and occasionally found in grain fields and fallow land, mainly as the variety *glabra*, T. & G. Leaves narrow, flowers white or rose-colored, turning to scarlet in fading.

**56. GAURA PARVIFLORA, Dougl.**

A tall, hairy annual or biennial, two or three feet high, with small flowers and long, slender spikes of spindle-shaped fruit, occasionally troublesome in grain fields and waste places in the Missouri river region. Apparently introduced from eastward.

## 57. GERANIUM CAROLINIANUM, L. CRANE'S-BILL.

The typical form occasional in waste places; the form *G. Bicknellii*, Britt. not infrequent in waste places in many parts of the state.

## 58. \*GERANIUM PUSILLUM, L.

Well established as a weed in fields and waste places about St. Ignatius, Flathead Reservation, and at Plains.

59. GLYCYRRHIZA LEPIDOTA, Pursh. WILD LIQUORICE;  
CUCKLEBUR.

A native perennial in low ground with pea-like leaves and bearing clusters of burs very like those of the true cucklebur (*Xanthium*). Its long, creeping, underground stem makes it difficult to eradicate from new land, and it is frequently abundant and troublesome in meadows and pastures. Persistent cultivation or digging seems to be the only remedy other than close pasturage.

## 60. GRINDELIA SQUARROSA, Dunal. ROSIN-WEED; WILD ARNICA.

A biennial doubtfully native in this region. About 18 inches high with a stiff stem and many heads of yellow-rayed flowers covered with a gummy secretion. Common in the plains and valleys east of the mountains and spreading westward. More frequent along roadsides and waste places and troublesome in meadows and pastures, where it is difficult to eradicate after having once obtained a foothold. Stock rarely will eat it in any situation. Just being introduced in the Flathead and Bitter Root valleys by roadsides and should be exterminated before it becomes established. Old settlers say the plant has come into much of this region since the advent of civilization and there seems now to be a steady advance westward, although its distribution is effected mainly by the conveyance of its seeds in the mud on the feet of animals and the wheels of vehicles and in hay.

## 61. HELIANTHUS ANNUUS, L. SUNFLOWER.

An annual weed, three or four feet high, with large notched leaves and large yellow-rayed heads three inches in diameter, common everywhere east of the Divide and one of the worst weeds in

grain fields and cultivated ground. Occasional along the rail-ways in the western part of the state, but not troublesome there except in the Bitter Root valley. It is confined to one or two small areas in the Flathead valley and shows small disposition to spread in the absence of irrigation, but if the farmers are wise they will stamp out this pest at once, lest it become as troublesome there as it has in other parts of the state. Seeds seem to be distributed largely by irrigation and in the mud adhering to feet and to the wheels of vehicles. Its seeds seem to lie in the ground many years before losing their vitality and it can best be combatted by sowing the infected fields in some annual grain suitable for forage and pasturing with sheep for several years.

#### 62. HELIANTHUS NUTTALLII, T. & G.

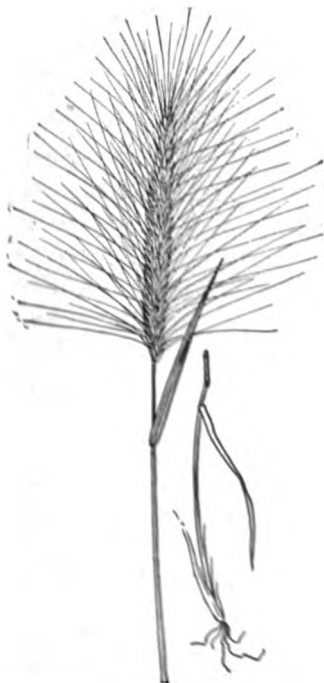


Fig 10. *Hordeum jubatum*, L.  
Natural size.

A native perennial sunflower, more slender and with narrower leaves than the last; roots tuberous and with frequent underground stems. Usually in small patches, and can best be destroyed by pulling or digging after irrigation. Often troublesome in grain fields and low ground in the western part of the state.

#### 63. HELIANTHUS PETIOLARIS, Nutt.

An annual very like and commonly confused with *H. annuus* above and frequent in dry, sandy situations in the Milk River and Yellowstone valleys. It has smaller heads than the common sunflower (*H. annuus*) and narrower, entire leaves.

#### 64. HORDEUM JUBATUM, L. FOXTAIL; SQUIRREL-TAIL GRASS; SLOUGH-GRASS.

An annual or biennial grass with a large, bushy spike of fruit, whose long

awns when ripe pierce the lips and tongue of stock and cause extensive ulceration. A common weed in pastures and waste places seemingly introduced from the east; doubtfully native. It makes little headway against the native vegetation, but tends to become established in low ground wherever that vegetation has been disturbed or kept down by close pasturage. Said to make fair hay, if cut before heading out or after the head breaks away in August. It may be killed out in most situations by plowing it under in June or by seeding the fields in grain for a few seasons. It is also doubtful if it can make much headway against a good stand of clover, timothy or alfalfa. [Fig. 10.]



Fig. 11. *Iva xanthiifolia*, Nutt. Plant 1-12 natural size; leaf and fruit  $\frac{1}{2}$ .

65. \**HYOSCYAMUS NIGER*, L.  
BLACK HENBANE.

A coarse European annual or biennial established in waste places at Billings (E. V. Wilcox), Big Timber, and rarely about Bozeman. Poisonous.

66. \**HYSSOPUS OFFICINALIS*, L. HYSSOP.

A sage-like perennial with narrow leaves and clustered blue flowers, occasionally escaped from gardens. Roadsides in Flat-head valley, rare.

67. *IVA AXILLARIS*, Pursh.  
BAZZLE-WEED; POVERTY-WEED.

A native perennial a foot or two high growing in clumps or forming extensive patches in low ground, particularly in alkaline soil. Its long creeping underground stems make it most difficult to eradicate. Probably best combatted by seeding down in meadow.

68. *IVA XANTHIIFOLIA*, Nutt. CARELESS-WEED; HORSE-WEED;

## GIANT RAG-WEED.

A tall, coarse native annual, three to six feet high, with large, heart-shaped toothed leaves opposite on the smooth stem. This is one of the worst weeds in the Gallatin valley, by roadsides, in waste places and cultivated ground, and is not infrequent in low ground east of the Divide, but apparently rare west of it.

Its small, black seeds seem to be distributed wholly by water and the mud of passage and so it is not apt to be very troublesome except in irrigated districts. [Fig. 11.]

69. *KRINITZKIA CRASSISEPALA*, Gray.

Frequent in loose soil with *Echinosperrum Redowskii* in the Yellowstone region; apparently not west of the Divide.

70. *LACTUCA PULCHELLA*, DC. MILKWEED;  
WILD LETTUCE.

A native perennial of the lettuce family common in all situations throughout the eastern part of the state; leaves smooth, often with long, slender teeth; flowers blue, closing in the afternoon. In low ground the long under-



Fig. 12. *Lactuca Scariola*, L. a, 1-9; b, natural size; c, enlarged.

The black seeds with a tuft of hairs at apex are distributed by the wind.

**71. LACTUCA SCARIOLA, L. PRICKLY LETTUCE; CHINESE  
LETTUCE.**

A European biennial resembling the preceding species, but the flowers are light yellow and the leaves are prickly-fringed and not lobed, and have a curious habit of twisting to the vertical with a tendency toward a north and south direction, like a "compass plant." A most pernicious weed introduced along the railroads in nearly every part of the state but most frequent from Missoula west and south and worst about Plains and Hamilton. It should be destroyed in the localities in which it is established and not permitted to spread and increase the number of our already too numerous European pests. [Fig. 12.]

**72. \*LAMIUM AMPLEXICAULE, L. DEAD NETTLE.**

A European annual introduced with garden seed from the east and well established near Ennis. A prostrate or creeping plant resembling the Ground Ivy, having small, rounded, opposite leaves with purple flowers in the axils. Unlikely to become troublesome except in irrigated gardens.

**73. \*LEONURUS CARDIACA, L. MOTHERWORT.**

A European perennial well established in waste places about Missoula, and one or two other points in the state.

**74. LEPACHYS COLUMNARIS, T. & G. CONE-FLOWER.**

A native perennial of the plains region, one or two feet high, with rough divided leaves and long-stalked flowers with a dark columnar disk and drooping yellow rays. Spreading westward and often troublesome in meadows, pastures and waste places, particularly in dry sandy soil.

**75. LEPIDIUM APETALUM. Willd. BIRD-SEED; PEPPER-GRASS.**

A small acrid-tasting annual a few inches to a foot high, frequent in dooryards, waste places and cultivated ground. Doubtfully native, although well distributed throughout the plains region. Seeds become mucilaginous when wet and thus facilitate their distribution by animals.

**76. LUPINUS PUSILLUS, Pursh. DWARF LUPINE.**

A small bulbous-rooted perennial, less than a foot high, with a long-stalked seven-foliate leaf and spike-like racemes of blue flowers, frequent in sandy soil in the Yellowstone and Milk River regions, and often troublesome in grain fields and cultivated ground. Native.

**77. LUPINUS SERICEUS, Pursh. LUPINE; PRAIRIE BEANS.**

A native perennial common in dry ground throughout the state. Like the last but larger, one to three feet high. Persistent with long, creeping rootstocks in new ground and difficult to exterminate except by digging or long cultivation.

**78. LYGOESMIA JUNCEA, Don. WILD ASPARAGUS; SKELETON-WEED.**

A slender-stemmed branching native plant, one or two feet high, apparently leafless, with purplish flowers and long penetrating rootstocks, often troublesome in cultivated ground in the region east of the Divide. [Fig. 13.]

**79. \*MADIA FILIPES, Gray. SMALL TARWEED.**

A small, slender Pacific Coast tarweed, which has reached our borders along the railways in the western part of the state. Well established in waste places about Troy, Libby and Thompson Falls. Annual.

**80. MADIA GLOMERATA, Hook. TARWEED.**

Another Pacific Coast annual similar to the last but much larger, about two feet high, with sticky, ill-smelling herbage and terminal clusters of inconspicuous flowers. In waste places, pastures and along roadsides eastward as far as Bozeman and appears to be rapidly spreading eastward in the state.

**81. \*MALVA PARVIFLORA, L. RUNNING MALLOW.**

A small annual European mallow, noted in waste places about Conrad on the G. F. & Can. Ry. (R. S. Williams), Thompson Falls and Plains.

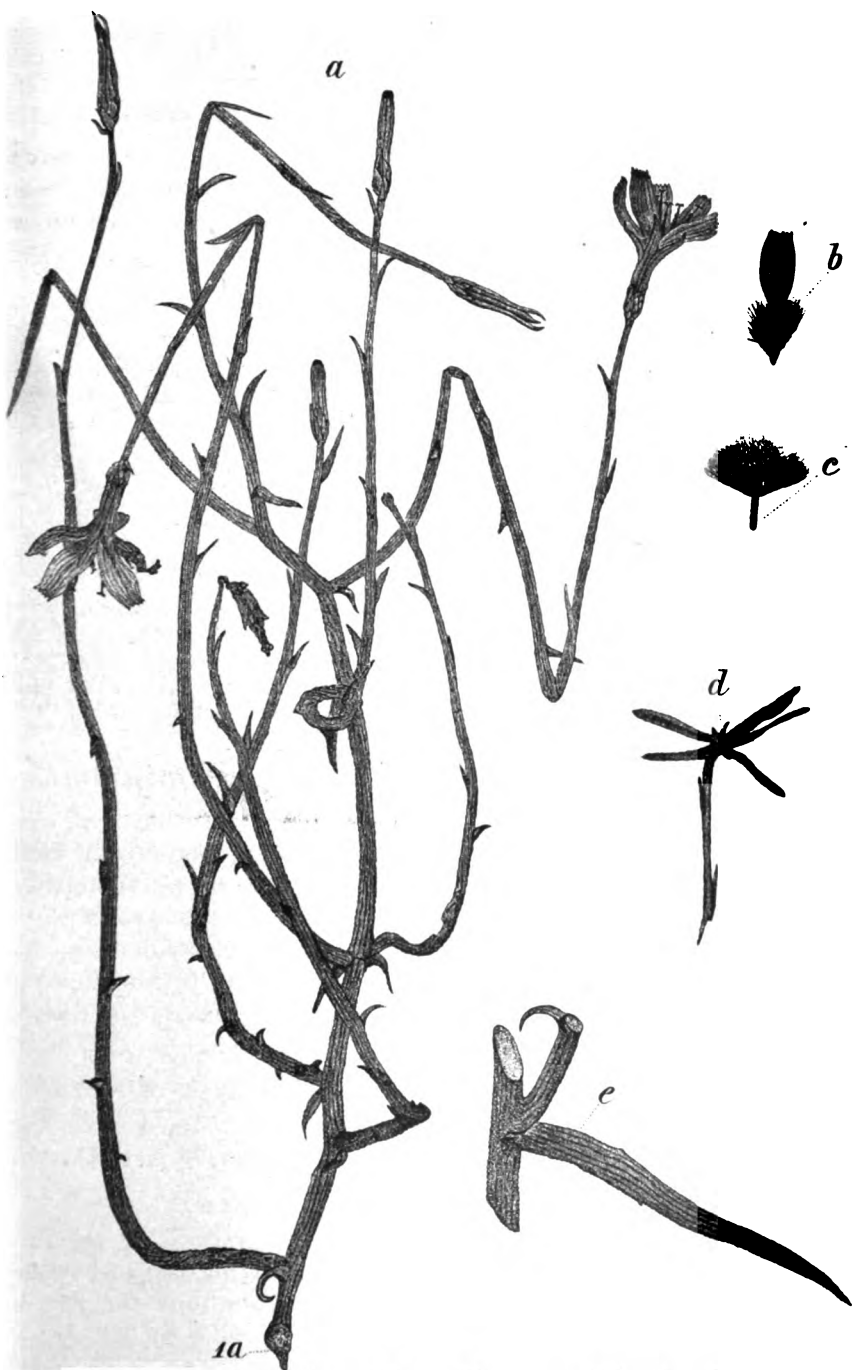


Fig. 13. *Lygodesmia juncea*, Don. Plant natural size; b-e enlarged.

**82. MALVASTRUM COCCINEUM, Gray. WILD HOLLYHOCK.**

A small native perennial about six inches high, with divided leaves, and brick-red flowers, not infrequent in waste places eastward, and often persistent in new ground; hardly large enough or sufficiently abundant to be troublesome.

**83. MARRUBIUM VULGARE, L. HOREHOUND.**

A white-woolly European perennial, one or two feet high, with opposite, roundish leaves, and the flowers and fruit clustered in the axils of the upper leaves. Seeds disseminated by the bur-like calyx. This has been found to be one of the worst weeds in Idaho and Utah, and is becoming very troublesome in streets, roadsides and waste places along the railroad from Missoula westward, but rare elsewhere in the state. Coming in from the west.

**84. MATRICARIA DISCOIDEA, DC. RAYLESS DOGFENNEL.**

A Pacific Coast annual resembling the dog-fennel (*Anthemis Cotula*) and similarly ill-scented, but without the white rays and much smaller. Frequent in streets and waste places and along highways throughout the western part of the state. Introduced from the west and rapidly spreading eastward.

**85. MELILOTUS ALBA, Lam. SWEET CLOVER; WHITE MELILOT;  
HONEY CLOVER.**

An annual or biennial, three to six feet high, frequent in many places along irrigation ditches and in waste places, particularly in the Yellowstone valley, where it has been found most troublesome. Much resembles alfalfa, but is taller and more slender and has white flowers, while its value as a forage plant is questionable. It appears to grow best in alkali ground. Introduced from Europe. Seeds appear to be scattered by water and in hay.

**86. \*MELILOTUS OFFICINALIS, Willd. YELLOW MELILOT.**

Like the preceding, but with yellow flowers. In waste places at Helena (F. D. Kelsey), White Sulphur Springs (R. N. Sutherlin), and Miles City. Infrequent.

**87. MONOLEPIS CHENOPODIOIDES, Moq. POVERTY WEED.**

A native annual prostrate or ascending with green inconspicuous flowers and abundant fruit; fruiting throughout the season.

much resembling *Chenopodium glaucum*. One of our most troublesome weeds in yards, gardens and waste places.

88. \**NASTURTIUM ARMORACIA*, Fries. HORSE RADISH.

In waste places an occasional escape from cultivation.

89. \**NEPETA CATARIA*, L. CATNIP.

A well-known European perennial becoming established in waste places at Helena (F. D. Kelsey), Columbia Falls, Holt, Thompson Falls, Plains and a few other places in the state.

90. *OENOTHERA BIENNIS*, L. YELLOW EVENING PRIMROSE.

A slender biennial three or four feet high with yellow flowers and spindle-shaped fruit about an inch long, introduced along the railroads and highways in most parts of the state and frequently so common as almost to appear native in low ground (*O. depressa*, Greene and *Onagra strigosa*, Rydberg).

91. *PANICUM CAPILLARE*, L. TUMBLE-GRASS.

A hairy annual grass with a widely spreading panicle of fruit easily detached when ripe; occurs occasionally in fields and waste places particularly in the Plains region. Here doubtfully native.

92. \**PANICUM CRUS-GALLI*, L. BARNYARD GRASS.

An introduced annual rare in fields, yards and waste places; here usually prostrate and spread by irrigation. At Ulm (R. S. Williams), Bozeman, Malta and Chinook.

93. \**PANICUM SANGUINALE*, L. CRAB-GRASS.

Occasionally imported from the east in grass seed, but shows little or no disposition to spread. Noted at Great Falls and Bozeman.

94. *PASTINACA SATIVA*, L. PARSNIP.

Often escapes from cultivation and is found occasionally in old fields, waste places and along irrigation ditches.

95. *PLANTAGO ASIATICA*, L. NATIVE PLANTAIN.

The common plantain in ditches and low ground by roadsides and in waste places, apparently native.

**96. PLANTAGO MAJOR, L. PLANTAIN.**

A European perennial abundantly introduced in lawns, pastures and waste places about Deer Lodge, Columbia Falls, Bozeman and most of the larger towns and cities of the state. Like the dandelion, it is difficult to eradicate from lawns except by digging. It should not be allowed to secure a foothold in a community. This species is very difficult to distinguish from the one above, except that it is smaller and more smooth, has shorter and more abrupt spikes of fruit, central dehiscence of the capsule and a more pestiferous habit of frequenting lawns, yards and waste places.

**97. PLANTAGO PATAGONICA GNAPHALIOIDES, Gray.  
RIBGRASS.**

A native annual of the plains region, frequent in dry ground and with a decided tendency to crowd out the grasses in pasture land, when close cropped. The variety *aristata*, Gray, occurs with the other form but is much less frequent. This has been quoted as a weed from this state, but has value as a forage plant. The seeds of all these plantains becomes mucilaginous when wet, adhere to everything they touch and so are easily transported in the mud of passage.

**98. \*POA ANNUA, L.**

A small annual grass from Europe, a few inches high in streets and waste places at St. Ignatius, Columbia Falls and a few other places in the state, but of no special importance.

**99. POLYGONUM AVICULARE, L. KNOTGRASS; YARDGRASS;  
GOOSEGRASS.**

An introduced annual forming carpet-like patches in yards, waste places, streets and along highways, often trailing for several feet. It has a smooth, wiry stem, small leaves and inconspicuous flowers. Common in beaten ground throughout the state; mainly in the coarser, blunt-leaved form (*P. littorale*, Link.), though both occur.

**100. POLYGONUM ERECTUM, L.**

An introduced weed very similar to the last, but is usually

erect and with broad oval leaves. Noted at Bozeman, Malta, the Ft. Peck Reservation near Calais, Forsyth and Glendive.

**101. POLYGONUM CONVULVULUS, L. WILD BUCKWHEAT.**

A climbing or trailing vine with heart-shaped leaves and buckwheat-like fruit common in yards, waste places and cultivated ground in the settled parts of the state. An annual introduced from Europe and the East and now become one of our worst weeds.

**102. POLYGONUM LAPATHIFOLIUM, L. SMARTWEED.**

A smooth annual with swollen joints and small terminal spikes of purplish or white flowers, one to three feet high. Introduced about waste places, gardens and in cultivated ground; not infrequent.

**103. POLYGONUM PERSICARIA, L. SMARTWEED.**

A not infrequent introduction in wet places, but hardly troublesome. Like the last, but lower and with thicker and more brightly colored spikes.

**104. \*PORTULACA OLERACEA, L. PURSELEY.**

A brittle, fleshy annual with small yellow flowers, forming broad mats. This eastern pest has appeared in gardens occasionally, introduced with garden seed, and grows vigorously in irrigated ground. Not likely to be more than locally troublesome, but should be exterminated in every case lest it become established and difficult to control. Noted in gardens and in waste places at Bozeman, Ennis, Craig, Forsyth and Glendive.

**105. RUMEX ACETOSELLA, L. SHEEP SORREL.**

A perennial one or two feet high with small leaves, having ear-like lobes on each side near the base and a strong acid taste, and with slender terminal naked sprays of small green flowers or fruit. Forms patches in meadows, pastures and waste land, spreading by means of long underground rootstocks, and, like the Canada thistle, very difficult to exterminate after it gets established. This is going to be one of the worst weeds in the state, as it is well adapted to our climatic conditions and has a footing in many places over the state, particularly westward. It has fairly taken



Fig. 14. *Ranunculus acetosella*, L. Plant natural size; 1 and 2 enlarged.

some grain-fields in the Gallatin Valley and is bad in several parts of the Flathead Valley, while it is common along the railroad from Missoula westward, apparently coming in from the Pacific coast. This should be included among the outlawed weeds of the state. [Fig. 14.]

106. *RUMEX CRISPUS*, L. CURLY-LEAVED DOCK; BURDOCK.

A large perennial dock established in streets and waste places about most of the larger towns of the state but not as yet common or very troublesome. The large thick roots must be removed by digging.

107. *RUMEX SALICIFOLIUS*, Weinm. WILLOW-LEAVED DOCK.

A coarse weed like the last but with narrower leaves; frequent along roadsides, in waste places and pastures. Apparently introduced from the west; possibly indigenous.

108. *SALSOLA KALI TRAGUS*, Moq. RUSSIAN THISTLE.

An introduced annual with little or no resemblance to a thistle. It has awl-shaped leaves, a green stem, striped with red, and prickly fruit-bracts, becoming hard and spiny in age; flowers and fruit small and inconspicuous. It often forms a large globular mass a yard or more in diameter, which finally becomes detached and is rolled about by the wind like the tumble-weed. It favors sandy or alkali soil for growth and frequents railway grades, streets and waste places about towns and cities; seems to make no headway against the native vegetation in the open fields and plains. This is one of the three outlawed weeds of Montana and doubtless well deserves to be included in the list, but, as far as my observation goes, it has not yet become a pest here in cultivated ground, although well scattered over the state, and hardly deserves the bad reputation given it. In its younger growth it makes fair forage and is occasionally cut for hay, so that it may yet prove a valuable forage plant adapted to alkali situations, where little else will grow. Well scattered in the Milk River and Yellowstone

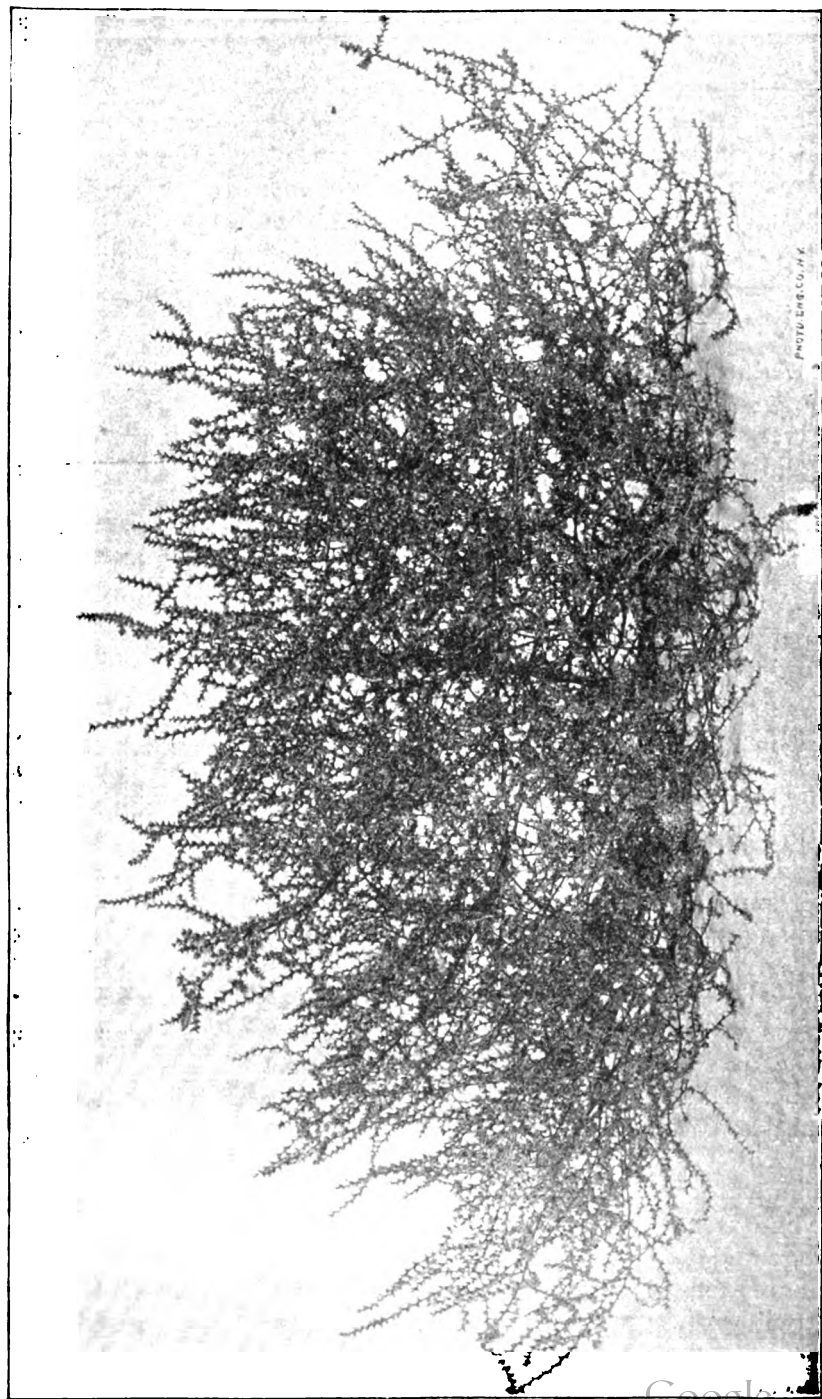


Fig. 15., a. Sholsola Kali Tragus, Moq. General habit of growth. 1-12 nat. size.



Fig. 15 b. *Salsola Kali* Tragus, Moq. Seedling and branch natural size; flower and fruit enlarged.

regions; at Missoula and Helena and reported from Manhattan, Livingston, Billings, Cinnabar, Great Falls and at points along the railway in Silver Bow and Beaverhead counties. It is easily uprooted with a hoe and should be piled into heaps and burned when dry, as the smallest plants bear fruit and will serve to restock the soil, if simply dug up and left. Mowing the plants, as is frequently done, is of little aid toward their extermination, as the stubs remaining will bear enough fruit to replant the soil for the ensuing season. It is better adapted to the conditions existing in the Milk River and Yellowstone Valleys than elsewhere in the state and may there prove a serious menace to the agricultural interests, but should be exterminated wherever found, as the law requires. Seeds distributed principally by the railways, irrigation ditches and mud of passage. [Fig. 15 a and b.]

**109. SAPONARIA VACCARIA, L. COCKLE; COW COCKLE.**

A smooth European annual, one or two feet high; with opposite, clasping leaves and conspicuous pink flowers terminating the level-topped spread of branches. A common and pernicious weed in grain fields in the eastern part of the state, but rare westward. It should not be allowed to secure a footing in regions not yet infected and may be hand-pulled where the plants are few or its distribution limited. Usually introduced and spread in the grain seed and, apparently, by irrigation. [Fig. 16.]

**110. \*SENECIO VULGARIS, L. GROUNDSEL.**

An annual, about a foot high, with divided leaves and inconspicuous heads of flowers, somewhat resembling a thistle. In waste places at Columbia Falls and Big Timber. From Europe.

**111. \*SILENE NOCTIFLORA, L. CATCHFLY.**

An introduced annual noted in fields and waste places about Bozeman. An herb one or two feet high, with sticky hairs, opposite leaves and white flowers. Unlikely to become troublesome in this state.



Fig. 16. *Saponaria vaccaria*, L. Plant about one-half natural size.

112. *SISYMBRIUM ALTISSIMUM*, L. TUMBLING MUSTARD.

Fig. 17a. *Sisymbrium altissimum*, L. a and d  $\frac{1}{3}$ ; b and c natural size.

A European annual of the mustard family, two or three feet high, with upper leaves narrow or finely divided and the lower broader-lobed, and having a widely branching, level-topped spread of yellowish flowers and slender fruit pods two or three inches long. This has been found to be a most pernicious weed in Canada north of this state and is extending southward. Specimens have been collected at Great Falls, Helena, Central Park and Belgrade, and it is fairly taking the grain fields in some parts of the Bitter Root and Flathead valleys. It should not be allowed to secure a footing in any agricultural section, as its enormous fertility,

tumbling habit, and special adaptation to our climate will probably make it far more dangerous to the farmer than any of the weeds already outlawed in the state. [Figs. 17 a and b.]

113. *SISYMBRIUM INCISUM*, Engelm. TANSY MUSTARD.

A slender annual of the mustard family, one to three feet high, having small, yellow flowers, short spreading pods and finely divided leaves. Common along roadsides, in grain fields and waste places. Has the appearance of a native in some parts of

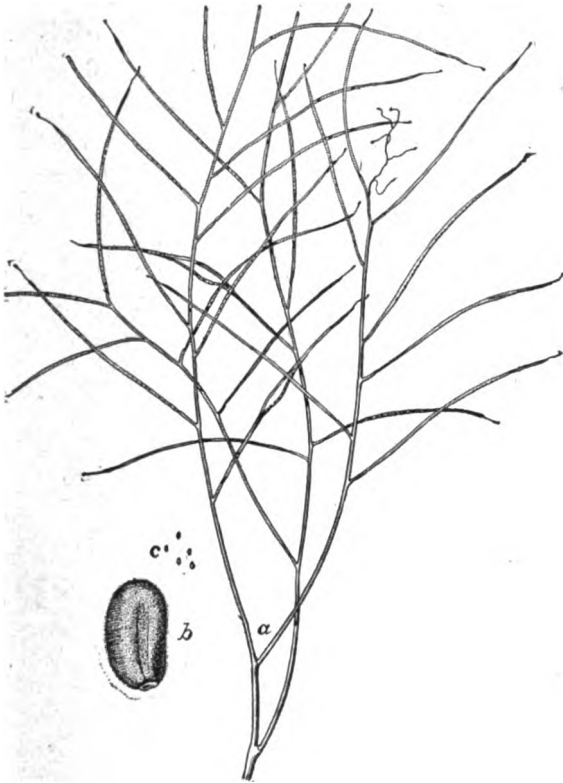


Fig. 17b. *Sisymbrium altissimum*, L. Fruit  
 $\frac{1}{4}$  natural size; b enlarged.

the state east of the Divide, but is local in its distribution. Seeds scattered by water and in mud.

114. \**SISYMBRIUM OFFICINALE*, Scop. HEDGE MUSTARD.

Another introduced annual, occasional in waste places, but not likely to become troublesome. At St. Ignatius, Troy, Helena, Bozeman and Missoula.

115. \**SOLANUM NIGRUM*, L. DEADLY NIGHTSHADE.

An introduced annual in waste places at Columbia Falls (R. S. Williams), and Selish (V. K. Chesnut).

**116. SOLANUM ROSTRATUM, Dunal. BUFFALO BUR.**

A prostrate annual, with yellow flowers and a bur-like fruit, thickly covered with long, yellow spines. Coming into the state from the east along the railways and becoming troublesome in yards, waste places and cultivated ground. At various points along the Yellowstone, Missoula, Box Elder Creek, Glasgow and Culbertson. It should be killed out in all localities before it becomes a pest. It spreads slowly, but holds well where established.

**117. SOLANUM TRIFLORUM, Nutt. WILD TOMATO; STINKWEED.**

A prostrate spreading annual with lobed leaves, small white or pale blue flowers and numerous green, many seeded berries. Frequent in gardens, waste places and cultivated ground throughout much of the region east of the Divide. The host of the Colorado potato beetle. Doubtfully native. [Fig. 18].

**118. SONCHUS ASPER, Vill. SOW THISTLE; YELLOW THISTLE.**

A thistle-like annual with spiny clasping leaves and yellow flowers; two or three feet tall. Introduced from Europe by way of the eastern states and now frequent and often troublesome in gardens and cultivated ground, particularly about Bozeman and Kalispell. Seeds feathery and scattered by the wind.

**119. \*SONCHUS OLERACEUS, L.**

Very similar to the last and commonly not distinguished from it. It is more slender, less prickly and has cross-ribbed seeds. It occurs with the other species, but is far less frequent.

**120. \*SPERGULA ARVENSIS, L. FIELD SPURRY.**

An annual introduced from the Old World with slender, branching stems and numerous clusters of thread-like leaves. In grain fields at Bozeman but not elsewhere noted.

**121. \*STELLARIA MEDIA, Smith. CHICKWEED.**

A small, spreading annual naturalized from Europe, in yards and waste places; occasional about Bozeman and other towns of the state.

**122. \*SUCKLEYA PETIOLARIS, Gray.**

A prostrate annual, very much resembling the pigweed-pursely (*Amaranthus blitoides*, Wats.) but with larger and more orbicular



Fig. 18. *Solanum triflorum*, Nutt. Branch natural size.

leaves. It has as yet been noted in this state only in the Milk River region and, as far as my observation goes, only in a single locality in the town of Glasgow. Its abundance and decided weed habit may hereafter make it a pest in that region. Although the type locality, it is doubtless introduced here from the southern plains.

123. \**SYMPHYTUM OFFICINALE*, L. COMFREY.

A large coarse European perennial sparingly introduced in waste places about Bozeman.



Fig. 19, *Taraxacum officinale*, Weber. Plant about  $\frac{1}{4}$  natural size.

124. *TARAXACUM OFFICINALE*, Weber. DANDELION.

A perennial of European origin, with a long, deeply penetrating root which makes it difficult to eradicate. It has a cluster of lobed ground leaves from which arise the slender flower stalks with yellow flowers and round balls of plumose fruit, which are carried long distances by the wind. One of the worst weeds in the state in lawns, waste places and pastures about the larger towns,

and can be exterminated only by cultivation or by digging; the latter is most effective when the roots are cut off just below the crown of leaves during the flowering season. Apparently well distributed in the state about towns. [Fig. 19.]

125. \**THLASPI ARVENSE*, L. PENNYCRESS.

An introduced annual of the Mustard family much resembling the birdseed (*Lepidium apetalum*) but having larger pods. Occasional in grain fields and waste places.

126. \**TRAGOPOGON PORRIFOLIUS*, L. SALSIFY; OYSTER-PLANT.

In gardens and waste places; not infrequently escaped from cultivation.

127. \**URTICA DIOICA*, L.

A perennial nettle about barnyards and in waste places in the Koutenai region. Infrequent. Apparently here, coming in from the west.

128. *URTICA GRACILIS*, Ait.

STINGING NETTLE.

A tall slender unbranched perennial with green fruit clusters in the axils of the upper leaves, and with stinging hairs. Not infrequent in streets and waste places and along highways in the region east of the Divide, but sparsely introduced westward. Usually regarded as native, but in this state its habit is wholly that of an introduced species and occurs only where its seeds may have been transported in hay, water or mud from points of settlement. [Fig. 20.]



Fig. 20. *Urtica gracilis*, Ait. Branch  
¼ natural size.

129. *VERBASCUM THAPSUS*, L. MULLEIN.

A thick, woolly-leaved biennial with a tall (two to six feet) unbranched stem and a terminal spike of yellow flowers. An introduced plant well established in many places about the state in fields and waste places and by roadsides. Most troublesome from Missoula south and west along the railroads. Common in the Flathead valley near Columbia Falls, along the Missouri below Craig and occasional in the Gallatin valley near Bozeman. Seems well adapted to our climatic conditions and is liable to become a serious pest.

130. *VERBENA BRACTEOSA*, Michx. TRAILING VERVAIN; VERVAIN.

A perennial, native in the region east of the mountains. It forms broad mats along roadsides, in yards and waste places. A prostrate and bristly hairy plant with small blue flowers along the ends of the branches.

131. *VERONICA PEREGRINA*, L.

A small annual not infrequent here as a weed in grain fields and cultivated ground, but hardly troublesome.

132. \**VERONICA BYZANTINA*, B. S. P.

A small weed occasionally introduced in garden seed, but has not yet become well established. Noted at Bozeman.

133. *XANTHIUM CANADENSE*, Mill. COCKLEBUR.

Fig. 21. *Xanthium Canadense*, Mill.  
Branch  $\frac{1}{8}$ ; bur natural size.

A coarse annual with heart-shaped leaves and clusters of hurs in their axils. Locally established along ditches and in low

ground in many parts of the state and seeds spread by stock and by irrigation. Rarely troublesome here in cultivated land. [Fig. 21.]

134. \*XANTHIUM SPINOSUM, L. THORNY CUCKLEBUR.

Specimens of this weed have been sent in from the vicinity of Victor and the plant is said to be well established about sheep camps in the Bitter Root region, probably brought in from the Pacific Coast with imported sheep. It has burs like the preceding but the leaves are more lobed and white beneath with long, three-divided yellow thorns in the axils. It should not be allowed to secure a footing in the state lest it become a serious pest to the wool industry and to agriculture.



ADDENDA.

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135. \**ERODIUM CICUTARIUM*, L'Her. ALFILARIA; PIN CLOVER.

A prostrate or spreading, much-branched annual with finely divided leaves and rose-colored flowers; fruit similar to that of the *Geranium*. Well established in waste places at Thompson Falls and Plains and is a fair forage plant. Imported from the Pacific Coast.

136. \**MADIA SATIVA*, L. TALL TARWEED.

Resembling *M. glomerata*, but is a taller plant (2 or 3 feet high) with heads terminating slender scattered branches. Frequent along roadsides and waste places at Thompson Falls, coming in from the Pacific Coast.

137. \**VERBASCUM BLATTARIA*, L. MOTH MULLEIN.

A smooth slender biennial 2 to 4 feet high with a cluster of toothed basal leaves and a terminal raceme of white (rarely yellow) flowers. Established along the railroad at various points west of Missoula and exhibits a strong disposition to spread. Noted at DeSmet, Weeksville and Thompson Falls.

138. \**VICIA SATIVA*, L. Vetch.

A European pea established along the railroad at Plains and its growth here would indicate that it might be profitably employed as a forage plant, as it is in Europe.

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44-12-54  
G.B.T.  
Sci 163535.7.

**BULLETIN No. 31.**

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**MONTANA AGRICULTURAL  
EXPERIMENT STATION**

**--OF THE--**

**MONTANA COLLEGE OF AGRICULTURE.**

---

**REPORT OF  
GRAZING AND FEEDING TESTS.  
BEEF CATTLE AND LAMBS.**

---

- I** Grazing alsike clover under irrigation.
  - II** Feeding steers for shipment.
  - III** Feeding lambs for shipment and for local markets.
    - 1. Utilizing waste products of the farm.
    - 2. Rations of clover and grain, clover and screenings and clover only.
    - 3. Ration of clover vs. grain hay.
    - 4. Rations similar, with and without constant access to water.
- 

**BOZEMAN, MONTANA, JUNE 1901.**

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**Gallatin County Republican,  
Bozeman, Montana.  
1901.**

**MONTANA AGRICULTURAL  
EXPERIMENT STATION,**  
BOZEMAN, MONTANA.

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All communications for the Experiment Station should be addressed to the Director,

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# Montana Experiment Station.

BULLETIN No. 31.

JUNE, 1901.

## GRAZING AND FEEDING TESTS.

R. S. SHAW.

### INTRODUCTION.

This bulletin has been prepared especially for the farmers and stockmen of Montana. It contains a simple statement of the results obtained from pasturing cattle on clover, and from the feeding of steers and lambs. In nearly every arable portion of the state the feeding of stock for market is a new industry. Many enquiries come to us asking for information relative to the work. Hence, as the work is new, we have commenced at the beginning and tried to secure the most important and practical data first. The more theoretical and scientific lines relating to this work we hope to take up later.

## PART I.

### Pasture Experiments.

In the month of June, 1900, an experiment was started to determine the productive capacity of our irrigated clover lands, under a grazing system. In other words to find how many animals a given area could support during the growing season, the number of pounds increase in the live weight and the value of this increase.

### Land Chosen.

This consisted practically of five acres, 5.04 by measure, fenced off from an alsike field, which had been seeded down during the summer of 1897. The soil consisted of a deep, rich humus, somewhat loamy, with a gravelly subsoil. This lot was divided into two parts about

### Animals Used.

### Gains Made by Steers on Alsike Pasture.

### Gains Made by Jersey Heifers Grazing With Steers.

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FIG. 1. YEARLING STEERS FATTENED ON CLOVER AND HAYLEY, PRECEDED BY CLOVER PASTURE

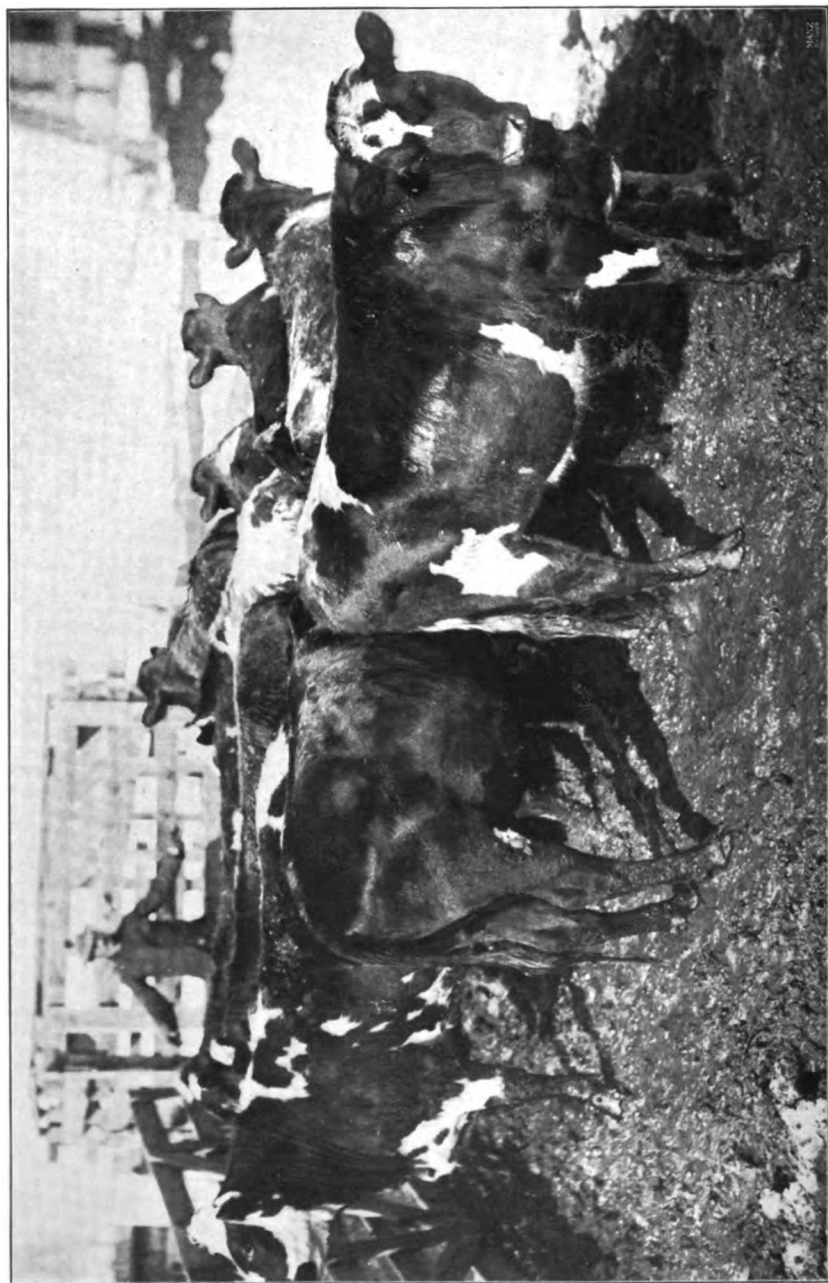


FIG. 2. YEARLING STEERS FATTENED ON CLOVER AND BARLEY, PRECEDED BY RANGE PASTURE

### Relative Gains.

An instructive feature of this experiment is brought out in the relative gains made by the beef steers as compared with the Jersey grade heifers. In the case of the steers, a gain of 2.75 lbs. per head, per day, was made, in comparison with 1.75 lbs. from the heifers. It should be said of the steers, however, that they were very thin at the time of going on the clover, hence, they not only grew rapidly but fattened very fast as well. Some of the heifers were a year older and comparatively in better flesh. The results, however, tend to indicate the greater meat producing powers of the steers, and that for this special purpose beef blood is essential.

### Capabilities of Alsike for Pasture Under Irrigation.

One question more freely asked than any other is "What area of clover is necessary to support a given number of animals throughout the growing season?" It was for the purpose of answering the above question that this test was made. The following is a statement of the number of days a given number of animals were kept on the 5.04 acres :

The 11 beef steers were on the pasture the equivalent of 108 days.

The 7 Jersey heifers were on the pasture the equivalent of 93 days.

From the time of turning on the pasture these animals were only removed once for a few days on account of irrigation and this has been considered in the computation. The 5.04 acres of alsike therefore not only maintained the eighteen steers and heifers for 102 days but enabled them to make a very profitable gain.

### Gains, in Pounds Increase from 5.04 Acres Alsike.

Total increase from 11 steers.....	3278 lbs.
" " " 1 steer which died.....	176 "
" " " 7 heifers.....	1106 "
Sum total.....	4560 "

### Cash Value of the Increase in Live Weight.

4560 lbs. gain at 4c. per pound.....	\$182.40
Cash return from each acre.....	36.19

### **The Only Source of Danger.**

This arises from loss by bloating. As already stated one steer died from bloat on August 24, 1900. This took place on a warm, bright morning following two days of drizzling rain, but while the pastures were still wet. Each individual has his own theories as to the conditions which cause bloating, and yet no one seems to hold good, for it takes place under an endless variety of conditions and is a great menace to the pasturing of clovers and alfalfa. It has been claimed by many that alsike is less liable to cause bloating than red clover or alfalfa and this seems to be true to some extent.

### **Results Encourage Grazing by the System Outlined.**

The possibilities for securing large returns from pasturing alsike, red clover and alfalfa are very great. In fact the results from this, the initial experiment, may seem overdrawn, but such are the facts. It must be remembered, however, that each half of the tract pastured was irrigated every two weeks. As an illustration of the productiveness of clover in the Gallatin Valley, we wish to call attention to the marvelous results obtained from the red clover hay which was secured from a portion of the Station farm during the summer of 1900. This tract of red clover, including 7.26 acres, at two cuttings, yielded 36 tons, 918 lbs., of well cured hay. It was irrigated three times, once before the first and twice before the second cutting. There was thus a return of 5.02 tons of red clover per acre from two cuttings.

As regards the productive and grazing power of red clover and alfalfa, in comparison with alsike, we as yet have not secured any data. This question will be tested as soon as the proper conditions can be secured. It is our opinion, however, that alsike will stand tramping and close grazing much better than red clover. It is a thick, matty, persistent grower. On a rich soil, with an abundance of water, its productive power is very great.

## PART II.

### Fattening Beef Cattle.

There is a growing demand for fat cattle to supply our local markets, which is worthy of the attention of the Montana stockman and farmer. Hitherto, the state has produced large numbers of fat cattle from its ranges, but these have all reached a finished condition at one season of the year and, consequently, have had to be shipped at that time in order to prevent loss from scanty food supplies and severe weather. Conditions, however, are rapidly changing with the settlement of the rich valleys which are being brought under irrigation. In many places the large stock owner is now able to supply food for his breeding herds or flocks during the winter season. In other sections, devoted more largely to strictly agricultural work, the farmer can produce enormous quantities of forage which cannot be disposed of to better advantage than in the fattening of live stock during the winter season. It is possible for our farmers not only to supply the local demand for beef and mutton throughout the year, but to prepare large number for shipping as well. During 1899-1900 steers were successfully fattened by this Station and placed on the local market as reported in bulletin 27. The following winter of 1900-1901 others were fattened, not so much for the purpose of carrying out feeding tests as for making a shipping trial.

### Animals Fed.

These consisted of the 11 steers used in the clover grazing experiment on the station farm during the summer of 1900, and also twenty steers secured from the range. Both lots were yearlings and mostly Shorthorn grades with one or two showing some Hereford blood. Those pastured on clover were in very much better flesh when put on feed, as the ranges of the autumn of 1900 were very scant. The twenty range steers were also at the disadvantage of having to be dehorned a few days before feeding began. The latter were purchased on Oct. 15, 1900, and both lots were given the run of the Station farm until Nov. 13, at which time they were put on feed. Their food during this time



Lot III. 10 steers, weight Nov. 13, 1900, 7375 lbs., average	737.5 lbs.
" III. 10 " " Mar. 30, 1901, 9720 " "	972.0 "
Total gain.....	2345 " "
Average daily gain per head during 137 days, 1.71 lbs.	234.5 "

Attention is called to the fact that the amount of food used was small considering the gains made. This may be attributed in a large measure to the quality of the food. The clover consisted of both first and second cutting hay, which had been cured in perfect condition under a cloudless sky. This clover retained all the blooms, which presented the same colorations they possessed on the day of cutting.

Throughout the 137 days during which the steers were fed there was not a single pound of waste from the roughage. Attention is also called to the fact that not more than one-half pound of barley meal, per 100 lbs. live weight, was fed each day. This is the amount which we had planned to follow throughout the feeding period. We believe that not more than this is necessary to give maximum results when fed along with roughage of the quality which can be produced in Montana. We are also convinced that maximum gains can be secured in cattle feeding in this state from a minimum amount of food. This is due to two agencies, first, an unexcelled quality of food, and, second, climatic conditions which are most favorable, viz., continual sunshine, proper temperature and quiet atmosphere.

#### Cost of Foods Used.

Lot I. Hay fed, 37,445 lbs., at \$5.00 per ton.....	\$ 93.63.
" I. Barley meal fed, 7530 lbs., at 70c. per cwt....	52.71.
Total value.....	146.34.
Cost per 100 pounds increase (including maintenance)	4.85.
Lot II. Hay fed, 29,335 lbs., at \$5.00 per ton.....	\$ 73.33.
" II. Barley meal fed, 7315 lbs., at 70c. per cwt.....	51.20.
Total value.....	124.53.
Cost per 100 pounds increase (including maintenance)	5.16.
Lot III. Hay fed, 29,235 lbs., at \$5.00 per ton.....	\$ 73.08.
" III. Barley meal fed, 7380 lbs., at 70c. per cwt....	51.66.
Total value.....	124.74.
Cost per 100 pounds increase (including maintenance)	5.31.

In the figures above given attention is called to the fact that the cost of increase diminishes according to the quality of the animals fed.

## Financial Statement.

Nov. 13, 1900, To 31 steers at \$25.00 per head	\$775.00.	
Mar. 30, 1901, To cost of feed, Lot I.....	146.34.	
"    "    "    "    "    "    "    "    II.....	124.53.	
"    "    "    "    "    "    "    "    III.....	124.74.	
"    "    "    "    "    "    "    "    shipping to Seattle	150.80.	
April 6, 1901, By 31 steers, 28880 lbs, at 5c...\$1444.00.		
"    "    "    To net profit.....	122.59.	
	<u>\$1444.00</u>	<u>\$1444.00.</u>

Net profit per head, \$3.95.

It will be noticed that feeding these yearling steers for 137 days, securing an average price for the food consumed by them and defraying all expenses, there was left a net profit on the carload of \$122.59, or \$3.95 per head. These steers were shipped to Seattle. Had there been a sufficient number of cars in the shipment to secure passage by stock train time, the shrinkage would not have been so great and the net profit relatively larger. The officials of the Northern Pacific railroad were extremely obliging in forwarding our car of cattle as expeditiously and comfortably as possible.

## PART III.

### Lamb Feeding Experiments.

These comprised the third series which have been conducted consecutively. The object sought has been to secure data relating to the fattening of lambs under Montana conditions and with home grown foods. The work of 1898 and 1899 consisted of a test of the comparative values of alfalfa, red clover and alsike hays, in which results were obtained showing that there was comparatively little difference among them. In 1899-'00 tests were made as to the gains and cost of production with the following rations, viz: (1) clover alone, (2) clover and unmarketable wheat, (3) clover and oats, with the following results:

From ration (1) a gain of 8.1 lbs per head, per month, at a cost of \$3.54 per 100 lbs. increase; from ration (2) 10 lbs. per head per month, at a cost of \$3.22 per 100 lbs. gain; and from lot (3) 10.5 lbs. per head, per month, at a cost of \$4.49 per 100 lbs. gain.

During the feeding season of 1900 and 1901, the following tests were made: A comparison of the results from the following: first, the feeding of clover and marketable grain, viz: Oats and barley. second, the feeding of clover and screenings, and third, the feeding of clover alone. A test was also made between clover and grain hay. The difference in results was also ascertained between two lots fed on the same ration but one with constant access to water and the other with water but once each day. A sixth lot was also fed, but not under experiment, the object being to produce a superior quality of lamb for the home markets.

These consisted of grade Merinos, showing some Leicester and Cotswold blood; they had been reared on the range and were thin at the time of purchase, Oct. 15, owing to the scarcity of food on the ranges during the autumn of 1900. In all 225 lambs were purchased, not picked, but cut out from a flock of several hundred. At the time of purchase these lambs averaged 50.86 lbs. The purchase price being \$2 per head, the cost per cwt. amounted to \$3.95. After having been weighed these lambs were given the run of the farm for thirty days. When the crop had been secured, 112 acres of the Station farm became available for pasturage. This area consisted of stubble from the following crops, viz: 14 acres of oats, 7 acres of wheat, 10 acres of barley, 12 acres of peas, 4 acres of plat grain, 4 acres grain hay and 4 acres of root and potato ground. The balance comprised 57 acres of clover stubble, five of which had been pastured closely throughout the season and two cuttings removed from the balance. The barley and wheat stubble grounds both possessed good stands of clover. On Oct. 15, 1900, 230 lambs went on the fields, weighing 11699 lbs., averaging 50.86 lbs. On Nov. 15, these were removed to the feed lots after having weighed 13948 lbs., averaging 60.64 lbs. The increase was therefore 9.78 lbs. per head for the month. This increase, which is large, was no doubt due to the great variety of food secured and the great abundance of the same. The benefit thus derived is a double one, arising, first, from the conversion of waste products into meat, and, second, to the thorough cleaning which the farm received.

This was made up of three lots of lambs of 53 each, with like yard and shed accomodation and constant access to an abundance of pure water which ran through the yards. Lot I was fed on clover and a grain ration of oats and barley, consisting of No. 1 marketable grain. Lot II received clover and screenings and Lot III clover only.

Lot I.	Nov. 16, 1900, to Fed. 13, 1901,	clover hay	13872 lbs at \$5 per ton	.....	\$ 34.68
" I.	" " " " " "	grain	2686 lbs at 85c. per cwt.	.....	22.83
	Total	.....			57.51

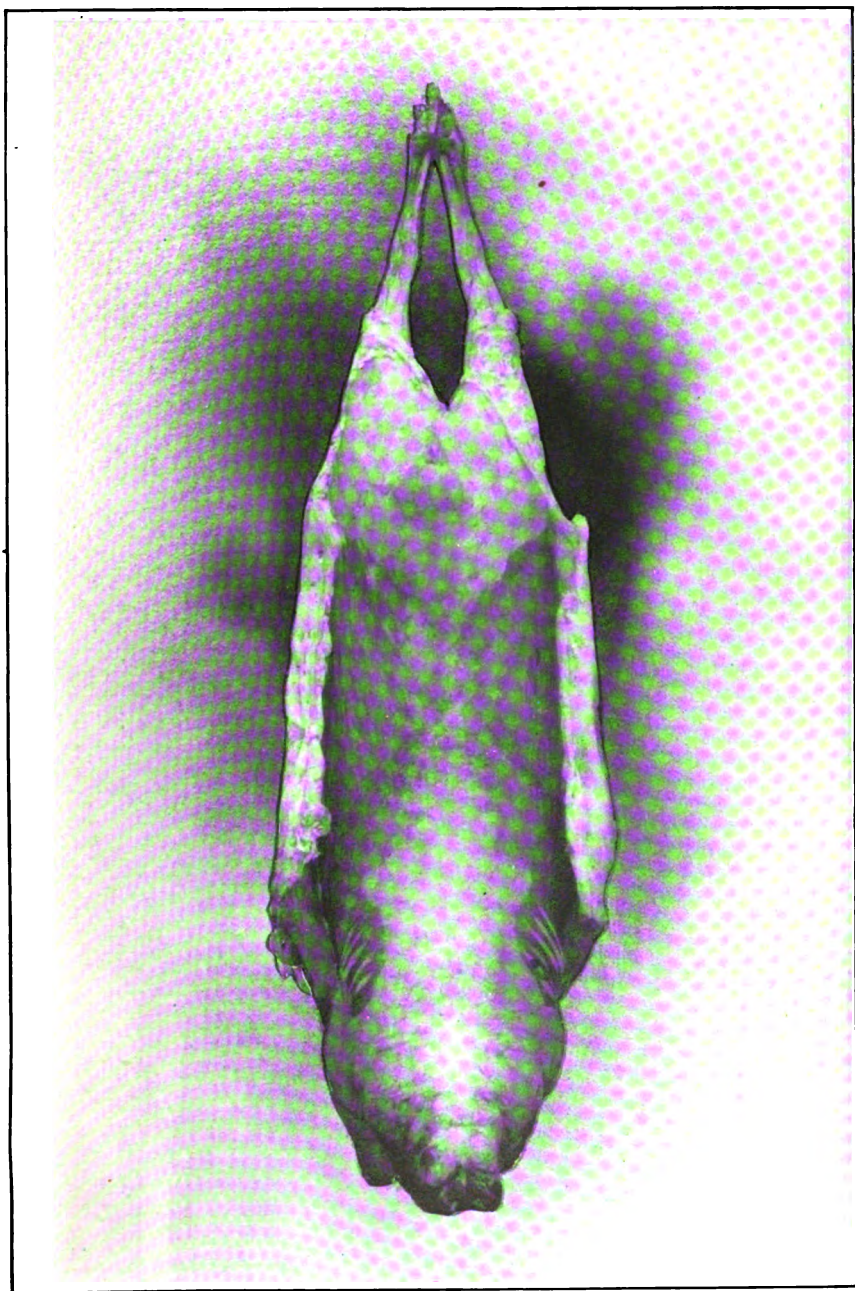


FIG. 5. BACK VIEW OF FIG. 3

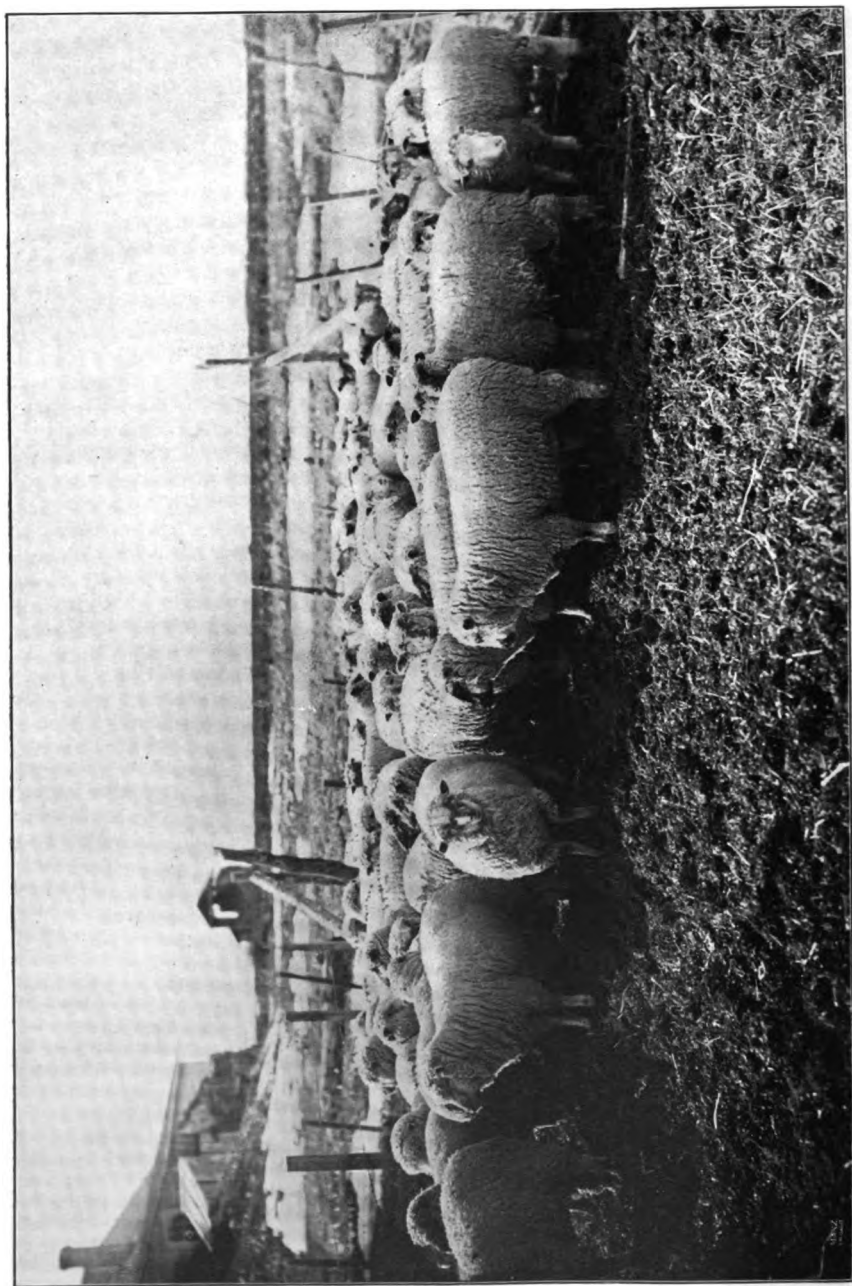


FIG. 6. SHROPSHIRE GRADE LAMBS. AGE, 11 MONTHS. AVERAGE WEIGHT, 119.5 LBS.

## FATTENING LAMBS.

13

Lot II. Nov. 16, 1900, to Feb. 13, 1901, clover hay, 14055 lbs. at \$5 per ton..	\$ 35.13
" II. " " " " " Screenings 2659 lbs. at 55c per cwt....	14.62
Total.....	49.75
Lot III. Nov. 16, 1900, to Feb. 13, 1901, clover hay, 15875 lbs at \$5 per ton..	39.68
Total.....	39.68

It will be noticed in Lot I, where clover and marketable grain were fed, that the cost of feeding is raised high above the other two because of the costliness of the grain and that as hereafter pointed out the increase was not enough to counterbalance the extra expense. Also that while the food of Lot III cost the least, the increase was not sufficient to render it the cheapest producer in the end.

### Gains Made.

Lot I. 53 lambs, weight Nov. 16, 1900.....	3215 lbs., average 60 <sup>7</sup> / <sub>16</sub> lbs.
Lot I. " " " Feb. 13, 1901.....	4538 " " 85.62 "
Total gain.....	1323 " " 24.96 "
Lot II. 53 lambs, weight Nov. 16, 1900.....	3260 lbs., average 61.5 lbs.
Lot II. " " " Feb. 13, 1901.....	4748 " " 89.58 "
Total gain.....	1488 " " 28.08 "
Lot III. 53 lambs, weight Nov. 16 1900.....	3245 " " 61.22 "
Lot III. " " " Feb. 13, 1901.....	4366 " " 82.37 "
Total gain.....	1121 " " 21.15 "

### Relative Amounts of Food Consumed.

Lot I. Clover consumed per head per day	2.9 lbs.
" I. Grain " " " "	.56 "
" II. Clover " " " "	2.94 "
" II. Screenings " " " "	.55 "
" III. Clover " " " "	3.32 "

### Relative Cost of Production.

Lot I. Cost per 100 pounds increase including maintenance	\$4.34
" II. " " " " " " "	3.34
" III. " " " " " " "	3.53

We conclude, therefore, that the most satisfactory results were secured from the ration of clover and screenings. More profitable because the increase was greater and the cost of production less. That the per capita gains should be greater from the lot fed screenings than those receiving first class grains may seem strange, but such are the results of this test. While Lot I received a few pounds less hay than Lot II this was about offset by their having received a little more grain. From practically the same number of pounds of food fed, Lot II receiving screenings, made a greater gain by 165 pounds than Lot I, receiving grain. While this is contrary to the general expectation, it no doubt depends largely upon the character of the screenings and the variety which it affords. In this case they were second screenings, containing an endless variety of grain and weed seeds and practically no light or chaffy material. In addition to the larger gain, the screening fed lambs cost \$1.00 less per hundred pounds increase. While the gains and cost of production from the clover fed lot were moderate, still they were not so satisfactory as those from Lot II, for the reason that the lambs were not in as good condition for market nor for withstanding the hardships of shipping.

We conclude, therefore, that it is best to use some grain along with alfalfa or clover in preparing lambs for shipping, that a large amount is not necessary because of the quality of our coarse foods. Not more than one-half pound of grain per day throughout a feeding period of ninety days, or the equivalent of this if fed only throughout the latter portion of the period. This will of course only apply in those cases where Montana grown legumes are used as roughage. Where first-class marketable grains are used it makes the ration too expensive. Good results can be secured from screenings or from cheap or unsalable grains.

## TEST NO. 2.

### Clover and Grain Hay Compared.

In many sections of Montana grain hay is grown to a large extent. It is most commonly grown at altitudes too high for the maturing of the grain or on foul tracts of land where weeds are being combatted. It has been used most extensively as a food for horses or for wintering over cows and calves. Enquiries have come regarding its use as a

fattening food, which lead us to secure data relative to its value for fattening lambs.

For this purpose, 7.38 tons were grown upon an area of 3.7 acres. Thus, while the yield is large, it does not give more than half the fodder secured from the same area of clover. The grains mixed for sowing were spring wheat, barley, oats and peas in equal amounts. This mixture was drilled in, irrigated twice during the summer and cut and cured as for hay when in the milk stage. Because of the bright, rich appearance of this fodder, intermixed with a good strong growth of peas and containing much immature grain, we expected excellent results from it.

Two lots of lambs of 53 each were used, one receiving clover and the other grain hay. One of these lots was the same as that used in the preceding test. The test was not conducted longer than 60 days because of the supply of grain hay giving out, some of which had been used for other purposes. These two lots were put on feed on Nov. 16, 1900, all other conditions except those of food being practically the same.

### Food Consumed.

By 53 lambs receiving clover only.—

From Nov. 16, 1900, to Jan. 14, 1901, 10780 lbs. clover at \$5 per ton....\$26.95.

By 53 lambs receiving grain hay only,—

From Nov. 16, 1900, to Jan. 14, 1901, 10420 lbs. grain hay at \$5 per ton \$26.05.

### Increase in Weight.

Nov. 16, 1900, weight clover fed lambs,	3245 lbs.,	average...	61.22 lbs.
Jan. 14, 1901, " " " "	3987 " "	...	75.22 "

Total gain.....	742 " "	14.00 "
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Nov. 16, 1900, weight hay fed lambs,	3210 lbs.,	average...	60.56 lbs.
Jan. 14, 1901, " " " "	3776 " "	...	71.24 "

Total gain.....	566 " "	10.68 "
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Therefore, during the 60 days trial the clover fed lambs made a gain of 14 lbs. per head, while those receiving grain hay gained only 10.68 lbs. each. Throughout this period of 60 days the clover lot pro-

duced 100 lbs. gain at the rate of \$3.63, as compared with \$4.60 from the grain hay. It should be noted, however, that a small amount more clover was consumed than grain hay, but not sufficient to materially affect the data.

While these figures represent in a practical way the comparative feeding values of clover and grain hay for fattening lambs, still, they may not represent accurately their relative food values for other classes of stock or from a standpoint of composition. While horses and cattle consume these readily there was much waste from the lambs, consisting of grain stems and vines of peas. The results from the use of the grain hay fell far below our expectations.

### TEST NO. III.

#### Effect of Water Supply on Fattening Lambs.

The impression prevails to some extent, fortunately not, however, among experienced sheep men, that a sheep can thrive and even fatten with the use of much less water than is really necessary. We, therefore, made it a part of our work to secure data relating to the results obtained from lambs on similar rations where in one case they had constant access to water, while in the other they were turned to water but once a day. In this case we were unable to handle a full pen of 53 lambs in each lot. Seventeen lambs of like quality, but a trifle, lighter were chosen and fed on the same food and in the same manner as Lot II, heretofore described as receiving clover hay and screenings. The seventeen lambs were given access to water but once a day while those of Lot II had constant access to water which ran through their yards.

#### Food Consumed by 17 Lambs.

From Nov. 16, 1900, to Feb. 13, 1901, clover 4722 lbs., at \$5 per ton.....	\$11.80
" " " " " screenings 884 lbs., at 55c. per cwt.....	4.64
Total.....	\$16.44

#### Gains Made by 17 Lambs.

Nov. 15, 1900, weight 961 lbs., average 56.53 lbs.	
Feb. 13, 1901, " 1326 " " 78.00 "	
Total gain.....	365 " " 21.47 "

### Average amount of Food fed per day to Lambs Watered Once a day.

Clover consumed per head per day.....	3.08 lbs.
Screenings " " " " " .....	.55 "

### Average Amount of Food fed per Day to Lambs with Water.

Clover consumed per head per day.....	2.94 lbs.
Screenings " " " " " .....	.55 "

### Comparative Gains.

Lambs with constant access to water gained....	9.36 lbs. per month.
" watered but once a day, " ....	7.15 " " "

### Comparative Cost of Increase.

Lambs with constant access to water.....	\$3.34 per 100 lbs. gain.
" watered but once a day.....	\$4.51 " " " "

It will thus be seen that a constant supply of pure water in the feeding pens materially affects both the increase in live weight and financial returns. From these two lots, fed the same food under precisely the same conditions except as to watering, those having constant access to the water made a larger gain per head per month by 2.21 lbs. and also produced 100 pounds gain at the rate of \$1.17 less. This data emphasizes strongly the necessity for a constant supply of pure water for fattening lambs.

### FINANCIAL STATEMENT.

In all 225 range lambs were purchased and put on feed to which 4 others were added. Of these 516 only will be considered in our financial statement as they comprised the carload which reached Chicago. The remainder were used for slaughter and placed on the local market.

## Food consumed by 229 lambs from Nov. 16, 1900, to Mar. 15, 1901:

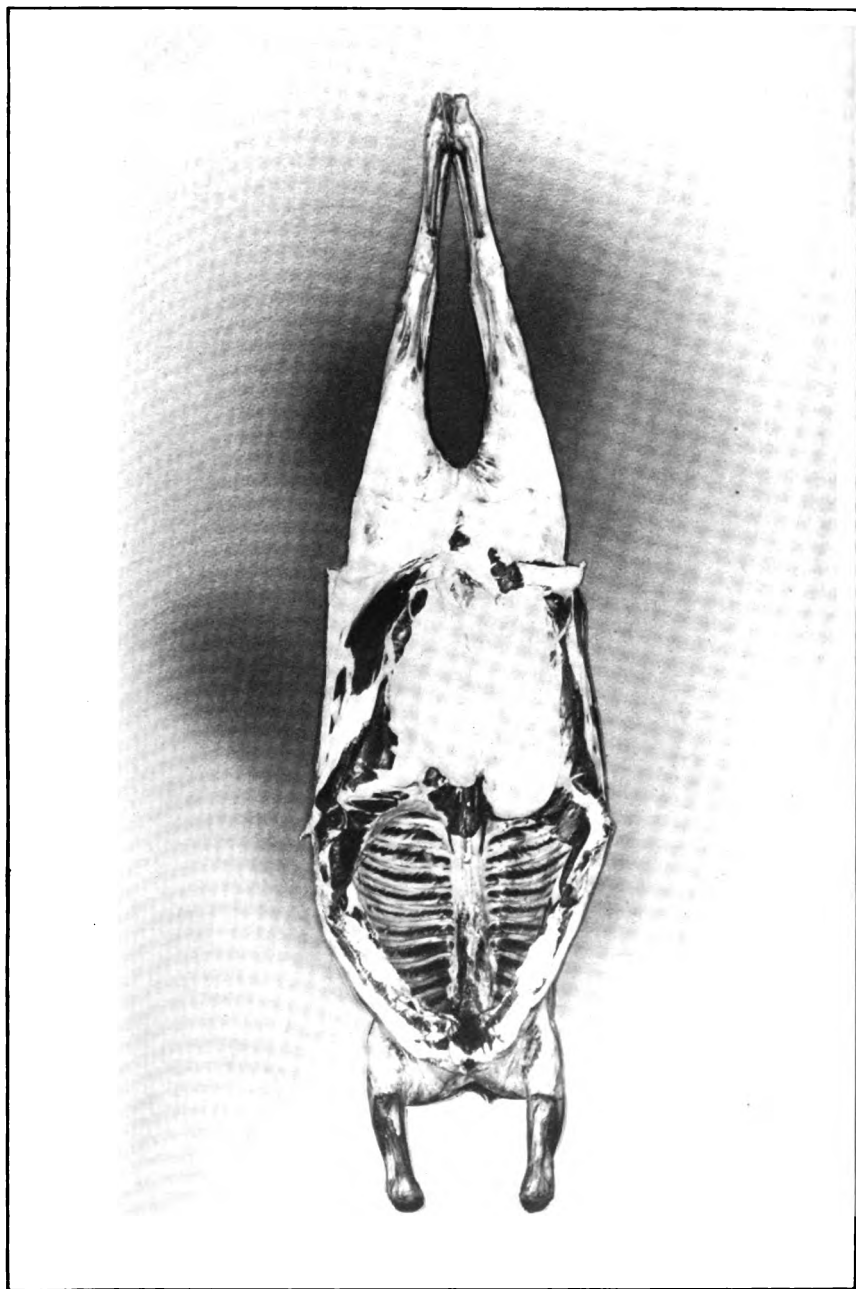
Clover, 65919 lbs. at \$5 per ton.....	\$164.79:
Grain hay, 10420 lbs. at \$5 per ton.....	26.05.
No. 1 grain, 3446 lbs. at 85c. per cwt.....	29.29.
Screenings, 4515 lbs. at 55c. per cwt.....	24.83.
Total cost of food for 229 lambs.....	\$244.96.
Cost of food per lamb.....	1.06.
Cost of food for 216 lambs shipped.....	230.90.
Nov. 15, 1900, to 216 lambs at \$2 per head.....	\$ 432.00
Mar. 15, 1901, to cost of food 120 days.....	230.90
Mar. 15, 1901, to freight, feed, yardage, commission, etc.....	181.39
Mar. 27, 1901, by 216 lambs sold in Chicago.....	\$908.29
Mar. 27, 1901, by net profit.....	64.00
	<u>\$908.29</u> <u>908.29</u>
Net profit per head .30.	

After the ninety day feeding test had closed the lambs were held for a number of days, as shown by the data. This was done in order to join other shipments and to take advantage of the rise in price. During this interval the gains were very unsatisfactory due to the annoyance and injury of many of the lambs by dogs from the city, the feeding yards being but a few hundred yards from the city limits. During the first visitation no less than forty lambs were bitten, a few dying afterwards. Though precautions were taken to prevent dogs from gaining access to the yards their presence in the vicinity at night kept the lambs constantly in a state of nervous excitement which rendered the feeding very unsatisfactory.

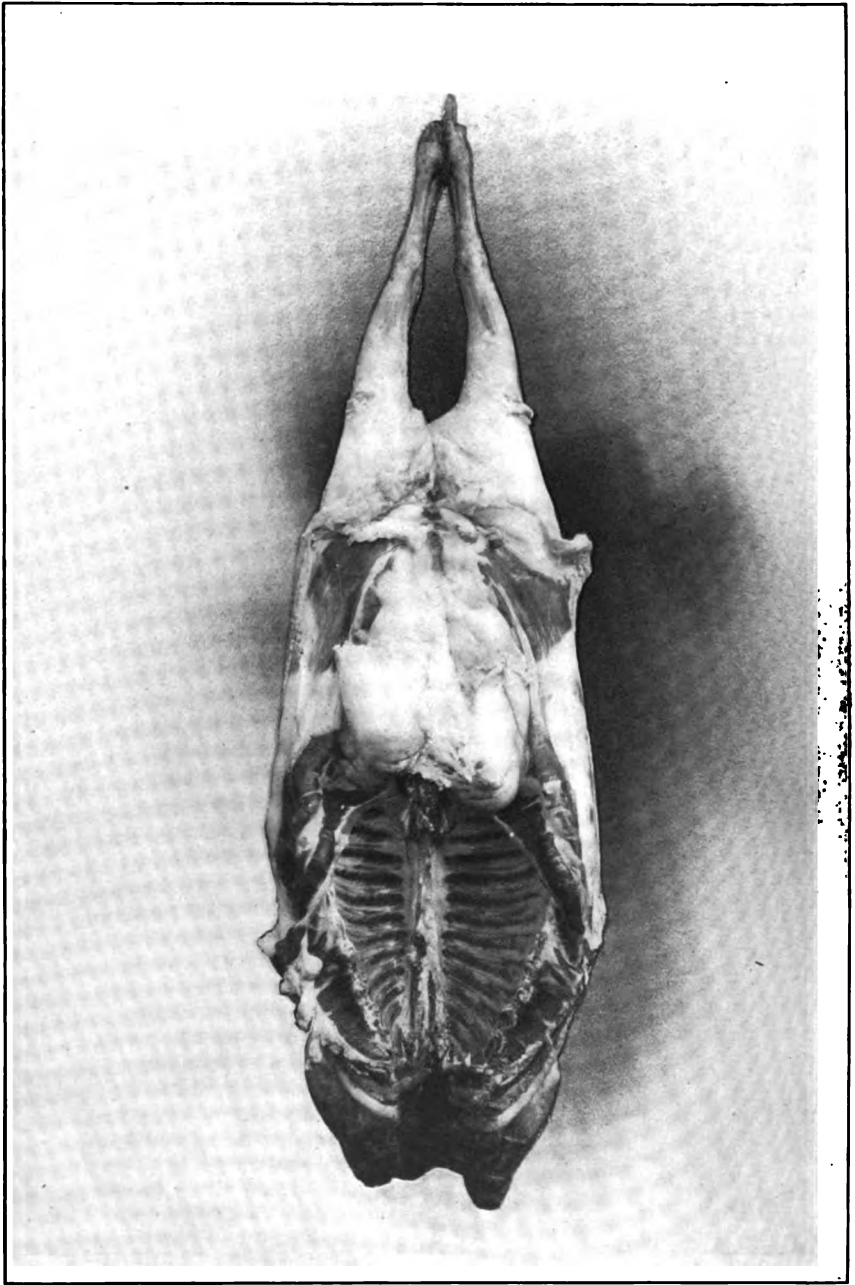
## Shrinkage.

Before shipping the lambs were taken from the feed yards and weighed, averaging 88 pounds per head. At the time of sale in Chicago the average weight was 80 pounds. The lambs were six days on the road between Bozeman and Chicago, there being but two cars of sheep in the train. We believe that this shrinkage is much larger than would take place when running on regular stock train time and with better conditions for feeding.

Unfortunately a heavy fall of snow preceded the shipment which, having melted, made it difficult to feed along all lines owing to water and mud.



**FIG. 4. CARCASS OF LAMB GROWN ON RANGE AND FATTENED ON CLOVER.  
11 MONTHS OLD; WEIGHT 54 LBS.**



**FIG 3. CARCASS OF LAMB 11 MONTHS OLD, GROWN ON CLOVER  
RANCH. WEIGHT, 74 LBS.**

### Market Prices Received.

The price received for the majority of these lambs in Chicago was \$5.30 per cwt., within ten cents of the top market price on the day of sale; some of the thinner ones sold at \$5.20. Because of the fact that this car lacked uniformity, consisting of lambs from five pens, each fed differently and some without any grain, we were well pleased with the sale. The lambs were sold by Messrs. Clay, Robinson & Co., of the Union Stock Yards, Chicago. These gentlemen were exceedingly diligent in keeping us posted as to the market conditions and the best time to forward the lambs. By acting on their advice we were enabled to secure the advantage of advanced prices after a depression extending over some two months, as shown by the market reports.

### Fattening Lambs for the Local Market.

In order to seek further information regarding the demands of our local markets 59 high grade Shropshire lambs were purchased from Mr. Roy Martin, of Bozeman, on Nov. 1st, 1900, and fed during a period of 135 days. At the time of purchase these lambs averaged 78.5 lbs. and the purchase price being \$3.00 per head, cost \$3.82 per cwt. The cost of feed for these lambs during 135 days was \$1.56 per head. These lambs were placed on the Bozeman market at a weight of 119.5 lbs. each. The price received for them was \$5.25 per head or \$4.40 per cwt. After charging up the feed at prices already given a net profit of 69 cents per head was realized. This profit would probably have been still larger had the lambs been disposed of earlier in the season, as they were fed beyond a condition of perfect finish. Figs. 3 and 5 show both front and rear cuts of a carcass from this lot which dressed 74 lbs. Fig. 6 shows the band of grade Shropshires which were fed and sold on the local markets.

### Conclusion.

The data relating to stock feeding furnished in this bulletin is given to the farmers and stockmen of Montana with the hope that it may at least provide some useful information relating to the feeding of stock for shipment. We wish to call particular attention to the fact that these statements may be regarded as very safe, for two reasons, first, where larger numbers are being purchased they can be secured more cheaply. While we paid \$2 per head for 225 lambs a band of 1300 near by was purchased for \$1.75 each; second, the market at the time our lambs were sold, though better than for some weeks, was much lower than the average the same season during a number of years past.

According to reports the western feeder came out about even during the past season, the live stock reports show this to have been the case. In the face of this fact, then, is it not encouraging to know that the shipment from this station netted a fair profit.

We cannot urge too strongly the practicability of sheep feeding in particular in our Montana valleys. Use alfalfa, red clover, or alsike with a small amount of grain. The secret of success in the future will be found in finishing a product better than the average which reaches the market. Those are the kind which feed and sell profitably.

**EIGHTH**

**ANNUAL REPORT**

**OF THE**

**AGRICULTURAL**

**EXPERIMENT STATION**

**OF THE**

**AGRICULTURAL COLLEGE**

**OF**

**MONTANA**

**FOR THE YEAR ENDING JUNE 30, 1901**



**BULLETIN NO. 32.**

**EIGHTH**  
**ANNUAL REPORT**  
**OF THE**  
**AGRICULTURAL**  
**EXPERIMENT STATION**  
**OF THE**  
**AGRICULTURAL COLLEGE**  
**OF**  
**MONTANA**

**FOR THE YEAR ENDING JUNE 30, 1901**

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**BOZEMAN CHRONICLE PRINT**  
**1902**



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APRIL 2, 1933

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## LETTER OF TRANSMITTAL.

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BOZEMAN, MONTANA, January 29, 1902.

To His Excellency, JOSEPH K. TOOLE,  
Governor of Montana.

DEAR SIR:—In accordance with the Congressional act of March 2, 1887, I have the honor to transmit herewith the eighth annual report of the Montana Experiment Station for the fiscal year ending June 30, 1901.

Very respectfully,  
S. FORTIER,  
Director.

# MONTANA AGRICULTURAL EXPERIMENT STATION

BOZEMAN, MONTANA.

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## STATE BOARD OF EDUCATION.

JOSEPH K. TOOLE, Governor,	} Ex-Officio.....	Helena
JAMES DONOVAN, Attorney-General,		
W. W. WELCH, Supt. of Public Instruction,		
J. M. HAMILTON.....		Missoula
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N. W. MCCONNELL.....		Helena
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O. P. CHISHOLM.....		Bozeman
J. G. MCCAY.....		Hamilton
G. T. PAUL.....		Dillon
N. B. HOLTER.....		Helena

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## EXECUTIVE BOARD.

WALTER S. HARTMAN, President.....	Bozeman
JOHN M. ROBINSON, Vice-President.....	Bozeman
PETER KOCH, Secretary.....	Bozeman
JOSEPH KOUNTZ.....	Bozeman
E. B. LAMME.....	Bozeman

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## STATION STAFF.

S. FORTIER, Ma. E.....	Director and Irrigation Engineer
F. W. TRAPHAGEN, Ph. D., F. C. S.....	Chemist
ROBT. S. SHAW, B. S. A.....	Agriculturist
J. W. BLANKINSHIP, Ph. D.....	Botanist
R. A. COOLEY, B. Sc.....	Entomologist

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Post Office, Express and Freight Station, Bozeman.

All communications for the Experiment Station should be addressed to the Director,

MONTANA EXPERIMENT STATION,  
Bozeman, Mont.

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**NOTICE**—The bulletins of the Station will be mailed free to any citizen of Montana who sends his name and address to the Station for that purpose.

## REPORT OF THE TREASURER.

The Experiment Station of the Agricultural College of the State of Montana in account with the United States appropriation, 1900-01.

DR.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1901, as per Act of Congress approved March 2, 1887.....\$15,000.00

CR.

By Salaries.....	8,129.38
Labor.....	3,000.00
Publications.....	1,518.31
Postage and stationery.....	171.62
Freight and express.....	286.37
Heat, light, water and power.....	266.45
Chemical supplies.....	89.82
Seeds, plants and sundry supplies.....	477.05
Fertilizers.....	9.50
Feeding stuffs.....	73.47
Library.....	116.25
Tools, implements and machinery.....	422.10
Furniture and fixtures.....	162.50
Scientific apparatus.....	277.18

Total.....\$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Experiment Station of the Agricultural College of the State of Montana for the fiscal year ending June 30, 1901; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been \$15,000.00, and the corresponding disbursements \$15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

Signed:

Attest:

PETER KOCH,  
Custodian.

JOHN M. ROBINSON,  
PETER KOCH,  
Auditors..

## REPORT OF THE DIRECTOR.

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The past year has been one of the most successful in the history of the Experiment Station. The various lines of work that were begun in the past have not only been maintained and their scope and usefulness extended, but new investigations have been undertaken. Each member of the Station Staff has striven to promote the particular industry which he represents, but at the same time there has been a disposition on the part of all to work harmoniously together for the two-fold purpose of benefitting the Montana farmer and building up a great experiment station. The prevailing sentiment among the Station workers is one of confidence in the present, and faith in the future. It is felt that this Experiment Station will soon occupy its rightful place at the head of the Agricultural College and lead the State in all those varied and important industries which are usually grouped under the term of agriculture.

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### AGRICULTURE IN MONTANA.

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It is a great privilege to assist in laying the foundation of what is destined to become the chief source of wealth to many millions of human beings. This State has been one of the last to develop its agricultural resources, but having now made a good start in this direction we believe that few states in the Union will be able to keep pace with it. There are good reasons for such belief. The State is well watered. Under arid conditions the

water supply is of first importance. Such streams as the Yellowstone, Madison, Jefferson and Missoula, the combined summer flow of which would irrigate one and a half million acres, are for the most part unutilized. The native grasses cannot be excelled. When these fail it needs but the thrifty farmer and the irrigation stream to convert the native meadows into productive alfalfa fields. With extensive pasture lands on the mountain slope and alfalfa stacks dotting the valleys, the stockmen should lead every state in the Union. Montana is also admirably adapted to diversified farming. The large yields of vegetables and fruits, grains and fodders that have been harvested for the past few years on the Station farm prove this fact. It will also become in time we believe, one of the leading dairy states. Wisconsin has made wonderful progress in the creamery industry. Last year the value of this product amounted to 22 million dollars. Yet, judged impartially, Montana is capable of surpassing Wisconsin in the production of butter and cheese.

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### THE WORK OF THE STATION.

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Having faith in the agricultural possibilities of Montana the Station officers are endeavoring to so plan and perform their work as to accomplish the most lasting benefits to the people of this State. A skilled mechanic must have tools and appliances before he can perform his allotted task. In like manner the Station scientist needs equipment. Several years have been spent in securing apparatus, fitting up laboratories, making collections and training assistants. This preliminary work is not yet completed, but enough has been done to enable the several departments to do good work along certain lines.

The chemical department is one of the best equipped and the excellent results which it has accomplished have fully justified the expenditure. Most of the knowledge that we now possess of the injurious ingredients in Montana soils, the analysis of potable waters, the adulteration of foods and the excellent quality of the Montana sugar beet has been derived from the Station chemist.

Through the untiring efforts of the agriculturist the Station farm has been transformed from a weed producing tract to a model farm, and his feeding experiments with domestic animals have attracted the attention of all Western stockmen.

The head of the botanical department has spent years of arduous toil in collecting specimens for its herbarium. He has now over 10,000 specimens of neatly mounted plants, forming one of the best collections in the West. During the past year considerable time has been given to injurious weeds and plants poisonous to stock.

The department of entomology was only recently established and in consequence much was required to be done in fitting up a laboratory, indexing the literature pertaining to the subject and making a collection of the insects injurious to the farmer and horticulturist.

The horticultural department is continuing to advance the interests of that important industry. Varieties of all kinds are being tested and those that prove the best are distributed in small lots at low figures among the home-builders of the State.

The poultry buildings and yards are now fairly well equipped and although a comparatively small amount of money has been expended on this industry, the character of the results has been excellent.

Through the liberality of the last State legislature an appropriation of \$2,500 was made to erect and equip a dairy. It is earnestly believed that the State will receive in the years to come one hundred fold from this investment.

In recognition of the fact that the Experiment Station is the only irrigation bureau in Montana the last legislative assembly voted the sum of \$2,000 to be expended in collecting data on irrigation. If one may judge from the nature of the correspondence which reaches this office, the irrigation investigations conducted by the Station have been highly valued by the irrigators of Montana.

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**CHANGE IN STATION POLICY.**

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The most important change in the policy of the Station has been made in the interests of the stockmen of the State. The feeding experiments with both sheep and cattle were carried on last winter in car load lots and sold in the principal markets. By this means a larger number of individuals were included in each test, the shrinkage in shipping as well as the actual expenses, selling prices and profits were determined.

The live stock owned by the Station has also been greatly improved. The scrub swine have been sold and replaced by thoroughbreds, the poorest cows have been exchanged for high grades and a sum of money set aside from both the College and Station funds for the purchase of thoroughbred Shorthorns and Herefords, as well as Rambouillet, Lincoln and Shropshire sheep.

The field of investigations has also been broadened. For a number of years nearly all the experiments were conducted either on the Station farm or in the immediate neighborhood. Farmers in other parts of the State formed the opinion that the Montana Experiment Station was established for the sole benefit of Gallatin county and not for the entire State. At the present writing there are over sixty farmers in different sections of Montana co-operating with this Station in the raising of grains, vegetables, legumes and grasses. The work of the chemist, agriculturist, botanist, entomologist and irrigation engineer have also been extended and include, as far as means and opportunity will permit, the entire State.

Greater freedom of action has been accorded the Station officers in performing the work allotted to each but with this privilege has been given greater responsibility. The harmony and good feeling that have prevailed as well as the excellent character of the work performed seem to have shown the wisdom of this change.

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**STATION STAFF.**

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With one exception there have been no important changes in the personnel of the Station staff during the year. Mr. S. M. Emery, who occupied the position of director and horticulturist for a number of years, resigned June 30, 1900, and the writer was appointed to succeed him. My term of office, as director, began, therefore, with the fiscal year just closed. In addition to my duties as director I was also placed in charge of the civil engineering course of the College and the irrigation department of the Station. Under such circumstances it was deemed advisable to group the work of the Station into several departments and place a competent Station officer at the head of each. In this way the head of each department could be held directly responsible not only for the character of the investigations conducted under his supervision, but also for the extent and quality of the contributions and publications.

Dr. F. W. Traphagen retained his position as Station chemist and supervised all sugar beet investigations within the State as well as the investigations pertaining to the adulteration of foods which were made in co-operation with the Bureau of Agriculture, Labor and Industry of Montana.

Prof. R. S. Shaw was placed in charge of the Station farm and given the care and management of all live stock. His most important duties were to conduct experiments in grain raising, forage crops and stock feeding.

Dr. J. W. Blankinship continued to act in the capacity of Station botanist and in addition to the labor involved in collecting specimens of the economic plants, investigated the plants poisonous to stock and the injurious weeds of the state.

Prof. R. A. Cooley succeeded himself as entomologist of the Experiment Station and inspector-at-large to the State Horticultural Board.

The horticultural department was placed in direct charge of Mr. Charles Wilson, who was to act under the supervision of the agriculturist and the director.

Mr. H. C. Gardiner was continued in charge of the sub-department of poultry.

All irrigation investigations and water supply measurements were placed under the supervision of the director.

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**STATION COUNCIL.**

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The members of the Station staff have held meetings once a month for the purpose of considering matters pertaining to the welfare of the Station. The candid expression of opinions at these meetings on all topics of vital interest has greatly aided the director and executive board to adopt wise measures in regard to plans for future work and the expenditure of Station funds.

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**NEEDS OF THE STATION.**

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I desire to call the attention of the members of the governing boards to the urgent needs of the Experiment Station.

In the first place it has no barns, granary or outbuildings worthy of the name. In this respect we rank below every other station in the Union. All our feeding experiments have had to be done under the most laborious and primitive methods. Our agriculturist has done splendid work in raising hundreds of varieties of grains. These have to be stored in log buildings and the mice cause endless trouble in mixing the varieties.

For the past two years the water supply for irrigation has been deficient. During the past season the flow was frequently less than 40 miner's inches for 160 acres of land. An additional supply of at least 25 miner's inches is required. More water is needed for experimental purposes than for ordinary farming.

It would also add greatly to the appearance and utility of the Station farm if a tract of land of about 10 acres, now unoccupied and for sale, located at the northeast corner of the farm could be purchased. In feeding sheep and cattle in car load lots it is difficult to raise enough feed on our limited area and likewise provide experimental tracts for the several departments as well as pasturage for live stock.

The present Station building is over crowded and provision must soon be made for additional class-rooms for farmers' boys who attend during the winter months. More space for laboratories and offices is also needed. The heating plant is now in the

basement of the main building with no facilities for extinguishing fires. There should be a separate heating building.

The Experiment Station should have a skilled veterinarian, thoroughly competent to undertake the bacteriological investigations of animal diseases. The stockmen of the State and the State veterinary surgeon desire it. Dr. M. E. Knowles has rendered valuable services to the State in many ways, but particularly in preventing the spread of animal diseases. The territory is so vast and the number of domestic animals so great that his time is fully occupied in police duties and the identification of diseases. It is of the utmost importance to the stock interests of Montana that this Station supplement the valuable work now done by the State veterinarian.

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#### **PUBLICATIONS.**

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The following bulletins have been published during the year. Of these, numbers 25, 26 and 27 belong to the previous year.

- No. 25. Paris Green and London Purple in Montana, by F. W. Traphagen.
  - No. 26. Poultry Raising, by H. C. Gardiner.
  - No. 27. Live Stock Feeding Tests, by R. S. Shaw.
  - No. 28. Seventh Annual Report.
  - No. 29. The Quantity of Water Used in Irrigation, by S. Fortier.
  - No. 30. Weeds of Montana, by J. W. Blankinship.
  - No. 31. Grazing and Feeding Tests, by R. S. Shaw.
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#### **FARMERS' INSTITUTES.**

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Through the efforts of the friends of agriculture a bill providing for the holding of Farmers' Institutes was passed by the last legislative assembly and received the approval of the Governor March 14, 1901. The Board of Administration consists of the Governor of the State, the presidents of the Montana Wool-Growers' Association, the Montana Live Stock Association and

the Montana Horticultural Society and the director of the Montana Experiment Station. Provision is also made to add the presidents of the dairy and agricultural associations to the board when these latter associations are organized. The Administrative Board is required to meet in November of each year to make the necessary arrangements to hold institutes during the winter months and also in March to arrange for the publication of the proceedings in a Farmers' Institute Annual.

The annual appropriation is \$2,000; but since a large portion of this sum will be expended in reporting and publishing the proceedings the balance will scarcely be sufficient to pay for traveling and incidental expenses.

The members of the Administrative board met in Helena June 10, 1901, and organized by electing A. L. Stone, of Missoula, president and S. Fortier, of Bozeman, secretary. On account of the lack of funds it was decided not to appoint for the present a superintendent of Farmers' Institutes and the secretary was given authority to arrange the dates and places of meeting as well as to secure voluntary speakers for each county institute.

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### CORRESPONDENCE.

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The correspondence of the Station is increasing rapidly. This may be regarded as a true index of the interest that is being taken in experiment station work in Montana. During the year over 2,500 letters have been received and answered. A large number of these came from the rural districts of the State. Many of the letters received from farmers and stock men required considerable time to answer for the reason that there were no Station circulars or bulletins which contained the desired information. As the number of the Station publications increase a greater variety of topics will be discussed and we hope to have in the near future more information to send to our correspondents.

Meanwhile we beg to assure all those who are interested in agricultural pursuits that we will cheerfully do what we can to reply to their enquiries and we hope that the farmers of the State will avail themselves of this opportunity of obtaining such information as this Station can give.

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**EXCHANGES.**

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Agricultural Experiments, Minneapolis, Minn.  
Agricultural Epitomist, Spencer, Ind.  
American Fancier, Johnston, N. Y.  
Avant Courier, Bozeman, Mont.  
Baltimore Sun, Baltimore, Md.  
Belt Valley Times, Belt, Mont.  
Big Timber Pioneer, Big Timber, Mont.  
Beet Sugar Gazette, Chicago, Ill.  
Billings Times, Billings, Mont.  
Bozeman Chronicle, Bozeman, Mont.  
Butcher's Advocate, Chicago, Ill.  
Carbon County Chronicle, Red Lodge, Mont.  
Chicago Drover's Journal, Union Stock Yards, Chicago, Ill.  
Commercial Poultry Journal, Draper Pub. Co., Chicago Ill.  
Dairy and Cream, 315 Dearborn St., Chicago, Ill.  
Dillon Tribune, Dillon, Mont.  
Elgin Dairy Report, Elgin, Ill.  
Farmers' Guide, Huntington, Ind.  
Farm Home, Springfield, Ill.  
Farm Journal, Philadelphia, Pa.  
Farmers' Institute, Chicago, Ill.  
Farm News, Springfield, Ohio.  
Farmers' Review, Chicago, Ill.  
Farm Poultry, Boston, Mass.  
Farm Stock and Fireside, Sioux City, Ia.  
Farm Stock and Home, Minneapolis, Minn.  
Feather, Washington, D. C.  
Florist's Review, Chicago, Ill.  
Gallatin County Republican, Bozeman, Mont.  
Glendive Independent, Glendive, Mont.  
Garden and Farm, Chicago, Ill.  
Home and Farm, Springfield, Mass.  
Home and Garden, St. Paul, Minn.  
Horticultural Visitor, Kinmundy, Ill.  
Holstein Register, Brattleboro, Vt.  
Independent, Helena, Mont.  
Inter-Mountain, Butte, Mont.  
Industrialist, Manhattan, Kan.  
Inter Lake, Kalispell, Mont.  
Inland Poultry Journal, Indianapolis, Ind.  
Irrigation Age, 916 W. Harrison St., Chicago, Ill.  
Jersey Bulletin, Indianapolis, Ind.  
Livingston Post, Livingston, Mont.

Madisonian, Virginia City, Mont.  
Milwaukee Journal, Milwaukee, Wis.  
Mining World, Butte, Mont.  
Montana Fruit Grower, Missoula, Mont.  
Modern Farmer, St. Joseph, Mo.  
National Stockman and Farmer, Chicago, Ill.  
Northwestern Poultry and Pets, Spokane, Wash.  
Ohio Farmer, Cleveland, Ohio.  
Opportunity, St. Paul, Minn.  
Orange Judd Farmer, Marquette Building, Chicago, Ill.  
Park and Cemetery and Landscape Gardening, Chicago, Ill.  
Progressive Farmer, New Port, Va.  
Plainsman, Plains, Mont.  
Poultry Culture, Kansas City, Mo.  
Poultry News, Lincoln, Neb.  
Poultry Herald, St. Paul, Minn.  
Poultry Journal, Spokane, Wash.  
Pacific Poultrymen, Tacoma, Wash.  
Rural Spirit, Portland, Ore.  
Rural New Yorker, New York, N. Y.  
Rural North West, Portland, Ore.  
Reliable Poultry Journal, Quincy, Ill.  
Stock Growers' Journal, Miles City, Mont.  
Strawberry Specialist, Kittrell, N. C.  
Stockman and Farmer, Helena, Mont.  
Southern Farm Magazine, Baltimore, Md.  
Tribune, Stevensville, Mont.  
The Weekly Chronicle, San Francisco, Calif.  
The Sentinel, Boulder, Mont.  
The World, Vancouver, B. C.  
Tribune-Review, Butte, Mont.  
Tribune, Great Falls, Mont.  
Up-to-Date, Indianapolis, Ind.  
Western News, Hamilton, Mont.  
Wallace Farmer, Des Moines, Ia.  
Wisconsin Agriculturist, Racine, Wis.  
Western Fruit Grower, St. Joseph, Mo.  
West Virginia Farm Review, Charleston, W. Va.  
Western Home Journal and Inter-Mountain, Spokane, Wash.

S. FORTIER,  
Director.

## AGRICULTURAL DEPARTMENT.

---

R. S. SHAW, Agriculturist.

Throughout this year the work of introducing and testing varieties of grains, grasses, forage and fodder plants and potatoes has been continued. The fourth season's work in the six year crop rotation has also been successfully completed. Much attention has also been given to culture methods relating to their effects on weed destruction and the maintenance of fertility. Some time and money have also been given to permanent improvement work and land reclamation. The greater portion of my time has been spent in the direct supervision of the farm labor, even to the routine work.

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### VARIETY TESTING OF GRAINS.

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**Wheats.**—Forty-three varieties were grown under irrigation. These consisted of a few new introductions, the balance of which had been grown from one to several years. The number was greatly decreased this year, some twenty-five or more worthless varieties having been discarded. The average yield from these forty-three varieties was 52.6 bushels per acre, and as the result of this season's work in conjunction with the data secured from previous years five selections were made on the basis of quantity and quality of product. These varieties are: Kubanka, Red Fife, Russian 2955, Wild Goose, Wellmans Fife and McKissocks Fife.

**Oats.**—These included thirty-three varieties chosen and handled in the same way as the wheats. The average yield was 87.9 bushels per acre. Four selections were made, viz.: Poland White, American White, White Wonder and Nameless Beauty. Two varieties chosen the previous year were increased this season to be put in the hands of farmers in various portions of the State, these were the Nameless Beauty and White Russian. From 1.48 acres the former yielded 129.7 bushels, or 87.3 bushels per acre, while the latter yielded 215.8 bushels from 1.96 acres, or 110 bushels per acre. After cleaning and grading, the White Russian oats weighed 44 pounds per measured bushel. Of these two oats, lots not exceeding five bushels were sent out to fifty farmers in different parts of the State. These were cleaned and graded and sold at the rate of \$1.25 per cwt. in response to inquiries for seed. In addition to this smaller trial lots, consisting of a few pounds, were distributed for trial in other locations. From this work we expect to secure returns which will tell us to what extent these varieties have been successful and also where the seed is located.

**Barley.**—Twenty-four varieties were grown in the same manner as the two preceding grains, giving an average yield of 48.9 bushels per acre. Seven varieties of the brewing kind, imported from Germany, were selected this year. Three kinds of hulless barley, viz.: Black, White and Smooth, selected and increased from previous years, were disposed of to farmers in several sections of the State to be grown for feeding purposes.

**Peas.**—From some ten or a dozen varieties tested, all have been discarded except two, viz.: Mummy and Canadian Golden Vine. Of these two, the former is a crown pea, an early maturing sort, characterized by a short, strong straw, producing large grain which all ripens at once. The Canadian Golden Vine is an indeterminate grower producing a much longer, more slender and yet heavier yield of straw per acre. These are a later kind. We recommend them where a large quantity of fodder is desired which can be controlled by the water supply. This pea will ripen up and produce an abundance of grain unless grown on moist ground or watered too freely. There has been a greater demand for the seed of these two peas than could be supplied.

*Rye.*—Some attention has been given to varieties of spring rye with the result that one has been chosen which yields 30.6 bushels per acre and produces a large yield of straw of a fine leafy character.

### GRASSES AND FORAGE PLANTS.

Twenty-six grasses have been grown, both with and without irrigation. Though this work is incomplete, and should extend throughout a number of years, some results are being secured as the work progresses. Of the total number, Brome Grass has proved to be the most drouth resistant; it is the first to start in the spring and the last to remain green during the season of drouth, quickly recuperating again in the autumn. It has produced one and one half tons of hay per acre where timothy, under similar conditions with scant soil moisture supply, only produced one half ton to the acre. Many failures to start Brome Grass have been due to the use of poor seed. When the germinating power of the seed is not known it is very difficult to get the right kind of a stand. If the grass comes up too thickly, matting soon results, and the growth becomes fine and spindly. Second in importance, as a drouth resister, followed a native rye grass, but while it possesses these good qualities they are partly offset by a growth somewhat too stemy devoid of leaves. The English and Italian rye grasses were found to be vigorous growers without irrigation, but failed to withstand the severity of the winter. The tenacity of life shown by Blue Grass under these dry conditions was surprising; it makes a remarkable growth early in the season, then dries up and makes a fine nutritious growth in the autumn.

Among the information of practical importance secured in this work was the discovery that the Montana grown grass seeds all possess a remarkably high germinating power, and we believe that the production of grass seeds can be made both practical and profitable.

Of the forage crops Dwarf Essex rape made a remarkably strong growth with one irrigating. It was, however, subject to

attacks from the green aphid which almost totally ruined the rutabaga crop during this same season.

**Root Crops.**—Of these, mangolds, sugar beets, carrots and rutabagas were grown for feeding purposes. The mangolds gave the largest yield per acre with carrots second and sugar beets third. The rutabagas were almost totally destroyed by the green aphid. These roots were all used for feeding purposes on the farm. The carrots proved to be an excellent food for horses feeding on straw. The mangolds were used for chicken and hog feed and the sugar beets were used exclusively by the hogs. Too much cannot be said in favor of the use of sugar beets for pigs which are being wintered over. They can be fed whole and raw and require little grain along with them to keep the pigs in a thrifty growing condition. From twelve to fifteen tons of sugar beets can be produced from one acre of land at a cost not exceeding \$25.00, if properly handled.

**Potatoes.**—In all fifty-two varieties were tested. In making selections of the best, most attention was given to those producing the largest percentage of marketable potatoes which was determined after culling out the small and large rough ones. It frequently happens that the sorts producing the greatest total yield per acre do not give the highest percentage of a marketable product. The following selections were made, viz.:

**Early Varieties.**—Six Weeks Market, Acme, Early Ohio, Early Oxford and Early Vaughan.

**Medium Varieties.**—Rural New Yorker No. 2, Lees Favorite, Snow Drop, American Wonder and Oregon Pearl.

**Late Varieties.**—White Maine.

### ROTATION TESTS.

During this season the fourth trial of the six year rotation experiment was made, with the following result:

#### YIELDS OF ROTATION ACRES FOR 1900.

Acre of	<i>Wheat</i> , grain.....	38.3 bu.
" "	" straw.....	3,000 lbs.
" "	<i>Clover</i> , hay.....	3,170 lbs.
" "	<i>Barley</i> , grain.....	87.2 bu.
" "	" straw.....	3,980 lbs.
" "	<i>Sugar Beets</i> .....	16,310 lbs.
" "	<i>Oats</i> , grain.....	75.5 bu.
" "	" straw.....	2,345 lbs.
" "	<i>Peas</i> , grain.....	37 bu.
" "	" straw.....	

With the exception of the sugar beets this record shows a steady increase in the productiveness of these six acres during the past four years. This season the sugar beet plants were badly damaged soon after coming through the ground as the result of the ravages of a flea beetle. Some fluctuations occur, due to climatic conditions, but in general the yields are satisfactory. While this is the case, however, the rotation is too wide for practicability.

### CO-OPERATION WITH FARMERS OF THE STATE.

Because of the great diversity of conditions, it was found necessary to adopt some means by which the work of the Station could be supplemented in as many other portions of the State as possible. In order to accomplish this, small quantities of grains, potatoes etc. were placed in the hands of private individuals for trial. The only conditions required were that accurate reports would be furnished. No less than seventy co-operators were secured. While results have not as yet been obtained from this work we feel that it will be of great benefit to the farmer directly and will bring much valuable information back to the Station which may be used in a practical way.

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**LIVE STOCK BREEDING AND FEEDING.**

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Importations of Berkshires and Poland Chinas were made during the year and both herds established with first-class stock to breed from. In all eighteen sales of breeding hogs were made as follows: In Gallatin county 12, Lewis and Clarke 2 and one each in Madison, Cascade, Missoula and Park.

In addition to these, two sales of breeding bucks were also made.

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**GRAZING AND FEEDING.**

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**Grazing Trials.**—In June of 1900, 5.04 acres was fenced off in two equal parts from an alsike field which had been seeded in 1897. The soil consisted of a deep, rich humus, somewhat loamy with a gravelly sub-soil. The two lots were irrigated alternately every two weeks from June 13th to August 18th and pastured in the same way. Twelve yearling Shorthorn and Hereford steers were chosen for the experiment. They were turned on the clover June 9th, remaining until October 1st. It was thought at first that the steers would be sufficient to consume the clover, but on June 18th it was necessary to add to their number to prevent waste. Consequently seven Jersey grade heifers belonging to the Station were turned in upon the clover also. During the experiment one steer died from bloat and all were removed for a few days while the pastures were wet.

On June 9th the twelve steers which were thin from wintering on the range averaged 545 pounds per head, on October 1st the eleven remaining averaged 783 pounds, making an increase of 3,278 pounds which with the gain of 176 pounds made by the steer before death gave a total increase of 3,454 pounds. The Jersey grade heifers, which were one and two years old, weighed 4,575 pounds on June 18th and 5,681 pounds on October 1st, making a total gain of 1,106 pounds. The relative gains were, therefore, for the steers 2.75 pounds per head per day, and for the heifers 1.69 pounds during the same time and under the same conditions.

This tract of 5.04 acres provided food for maintenance and the gains given, for eleven steers during the equivalent of 108 days, and also for the seven heifers 93 days, after taking into consideration the loss of the twelfth steer and the few days the cattle were removed from the pastures.

A sum total of 4,560 pounds animal increase was secured from the 5.04 acres of alsike clover, which amount valued at four cents per pound, gives a cash value of \$182.40, or \$36.19 per acre.

### FEEDING STEERS FOR MARKET.

Thirty-one steers were fed for shipment, consisting of the eleven steers used in the grazing test and twenty additional yearlings secured from the range. The feeding began November 13th, 1900, when the steers were divided into three lots according to quality. Those from the clover were fed separately.

The food consumed by the steers from November 13th to March 30th was as follows: Lot I (eleven steers) 37,455 pounds clover and 7,530 pounds barley meal. Lot II (ten steers) 29,335 pounds clover and 7,315 pounds barley meal. Lot III (ten steers) 29,235 pounds clover and 7,308 pounds barley meal. The average daily consumption of food, per capita, during 137 days was, for Lot I, 24.8 pounds clover and 5 pounds barley meal; lot II, 21.4 pounds clover and 5.34 pounds meal; lot III, 21.3 pounds clover and 5.39 pounds meal.

The following gains were made during the 137 day feeding period:

Lot I, eleven steers,	3,015 lbs.	averaging	247.1 lbs.	per capita
" II, ten "	2,410 "	" "	241 "	" "
" III, " "	2,345 "	" "	234.5 "	" "

The average daily gains per capita for the three lots throughout the period were 2, 1.75 and 1.71 pounds respectively.

The large gains from such light feeding are attributed to the superior quality of the food and the extremely suitable climatic conditions. The clover had been cured beneath a cloudless sky

and the feeding period consisted of an almost uninterrupted succession of bright still days. The steers were fed in open yards.

We have found with legumes of such quality as can be produced in our valleys that maximum gains can be secured from the use of a minimum amount of grain. Not more than one half pound, per day, per one hundred pounds of live weight is required.

The foods were charged up at \$5.00 per ton for clover and 70 cents per cwt. for barley meal, resulting in a total cost of \$146.34 for lot I, \$124.53 for lot II and \$124.71 for lot III. Therefore from the data given we get the following comparative costs per one hundred pounds increase, viz.: \$4.85, \$5.16 and \$5.31, the cost increasing as the lots lacked in beef type.

These steers were shipped to Seattle, where the sale resulted in a net profit of \$122.59 on the car load, notwithstanding the disadvantage of their age, weight and the heavy shrinkage resulting from the five day trip.

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### SHEEP FEEDING EXPERIMENTS.

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**Test No. I.**—Consisted of three lots of lambs of 53 each, receiving the following rations: Pen (1), clover and grain ration of oats and barley; pen (2), clover and screenings; and pen (3), clover only. The relative amounts of food consumed per head per day were: Pen (1), clover 2.9 pounds, grain .56 pounds; pen (2), clover 2.94 pounds and .55 pounds screenings; pen (3), clover 3.32 pounds. The average gains per head per month throughout the 90 days were: Pen (1) 24.96 pounds; pen (2) 28.08 pounds and pen (3) 21.15 pounds. The relative cost of production per 100 pounds was, pen (1) \$4.34, pen (2) \$3.34 and pen (3) \$3.53. We concluded, therefore, that the most profitable results were secured from the clover and screenings because the increase was greater and the cost of production less. Clover was charged at \$5.00 per ton, oats and barley at 85 cents per cwt. and screenings at 55 cents.

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### CLOVER AND GRAIN HAY COMPARED.

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**Test No. II.**—The same number of lambs was used as in the previous test and under the same conditions. The grain hay consisted of a mixture of oats, peas, barley and spring wheat grown together and cut early in the milk stage. The test was conducted for 60 days and both foods charged up at the price already given for clover.

During these 60 days the clover fed lambs made a gain of 14 pounds per head, while those receiving grain hay gained only 10.68 pounds. The former also produced 100 pounds increase at a cost of \$3.63 as compared with \$4.60 from the grain hay lot. There was too much waste from the grain hay and we believe that horses or cattle could have used this food to better advantage.

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### EFFECT OF WATER SUPPLY ON FATTENING LAMBS.

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**Test No. III.**—Two lots with food and surrounding conditions alike were treated differently as to water supply. One had constant access to water in the yard, the other was turned to water but once a day. The lambs with constant access to water gained 9.36 pounds each, per month; the others gained but 7.15 pounds in the same time. Those which were permitted to take water at will produced 100 pounds gain at \$3.34 while those with restricted supply cost \$4.51 for the same amount.

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### CORRESPONDENCE.

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The correspondence sent out by me from my department for the year amounted to 442 letters. Many of these were answers to inquiries relating to methods of cultivation, seeding, treating seed grain and requests for information relating to the various kinds of farm products. Many inquiries were also made in regard to live stock and methods of feeding.

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## PRESS CONTRIBUTIONS.

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Seventeen articles were contributed to the local press. These treated of subjects relating directly to the agriculture of Montana and presented in greater part some minor results of Station work not sufficiently important to warrant special publications. Some of the subjects presented were: Sheep Feeding in Montana, Stock Feeding Tests at the Experiment Station, Formalin Treatment for Grain Smuts, Alfalfa for Seed, Co-operation Between the Montana Farmer and the Experiment Station, a series of seven articles on Swine Feeding, Utilizing the Waste Products of Western Farms, etc.

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### FORMALIN TREATMENT FOR GRAIN SMUTS.

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About one year ago reports were sent out from the Experiment Station regarding the use of formalin as a preventive of grain smuts. Since that time another year's experience has been added, verifying the work of the three preceding years.

As requests are coming in daily, asking for instructions as to the use of formalin, we find it necessary to again make our reports far-reaching through the kindness of the press of the State.

Though many different methods of treatment for grain smuts have been devised and tried, none have proven to be more perfect preventatives than formalin. It is pre-eminently a germ destroyer and its work is perfect. It does not in any way injure the vitality of the grain. It is a comparatively inexpensive method and is easily applied.

For oat, barley and wheat smuts a mixture of one pound or pint of formalin to forty gallons of water will be effectual. We have used one pound to thirty-five gallons of water without injury. One pound of formalin used in the proportion given will treat from forty to fifty bushels of grain.

**Application.**—Either the dipping or sprinkling method may be used with good results and the method chosen will depend upon the facilities at hand for doing the work.

***Sprinkling Method.***—May be used where floor space or a number of sheets are available. The grain should be spread out thin and the moisture applied with a common watering can, while the grain is being constantly shoveled to insure a thorough application, upon which the effectiveness depends. After a thorough application has been made, the grain should be heaped and allowed to stand for two hours before being spread to dry.

***Dipping Method.***—This is the most sure as the application is likely to be the most perfect. The sacks containing grain can be immersed in a barrel or trough containing the mixture. The grain should be allowed to remain in the sacks at least two hours before being spread to dry. In both cases the grain should be dried perfectly, except when sown immediately after. In all cases the sacks should be treated. With wheat it is only necessary to wet the outer surface of the grain, but with oats and barley, the application should be made to penetrate the hulls, where spores may have found lodgment. This is accomplished by immersing for a few minutes and then allowing the grain to stand in the sacks as directed, or in a pile if sprinkled.

Formalin has also been successfully used for potato scab by immersing the uncut seed for from one to two hours in a mixture of one pound of formalin to thirty gallons of water.

Formalin is also known as formaldehyde and formic aldehyde. It is a powerful germ destroyer and an extremely active substance. It is sold in the liquid form at about fifty cents per pound and can be secured in most of the drug stores of the State. We cannot urge its use too strongly. Farmers in the vicinity of Bozeman, who have used formalin, report favorably.

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#### WASTE PRODUCTS OF WESTERN FARMS MAY BECOME A SOURCE OF PROFITABLE GAIN THROUGH THE USE OF LIVE STOCK.

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After the season of harvest is past, the work of threshing completed and the crops removed for storage or shipment, large quantities of food products still remain on the western farm. While the enormous crops of grain are being secured, there is

always some loss occurring during the process of harvesting, handling and threshing, thus leaving some grain on the fields of even the most careful farmer. These losses are due to the falling of many heads of grain from the sheaf in harvesting or subsequent handling; or, because of their plumpness and weight, some break loose from the stem and are lost; in other cases, again, innumerable grains "shatter out" and fall to the ground as the result of climatic effects peculiar to the arid west. Thus, it follows that much grain remains on the stubble field. It is to these we refer as "waste products," and such they are, unless recovered and converted into a marketable product. And it is through the use of live stock only that they can be turned to profitable account.

In addition to the grains left among the stubble, the meadows or clover fields provide a late growth, which may be used by some kind of stock. Then there are always some weeds and grasses, found bordering along ditches, fences and roads, which can be made use of.

On the majority of western farms no return is secured from these so-called waste materials, except such as is picked up by a few swine on an occasional ranch. The greater portion of this material is, however, generally lost.

In securing lambs, prior to the time of winter feeding, the Montana Experiment Station was enabled to obtain data which gives valuable information relating to the relative capabilities of cattle, sheep and swine, to utilize the waste products of the farm and also the return which could be secured from it.

After the crop had been secured, one hundred and twelve acres of the Station farm became available as a run for stock. This area consisted of stubble from 14 acres of oats, 7 acres wheat, 10 acres barley, 12 acres field and garden peas, 4 acres plat grain, 4 acres grain hay and 4 acres root and potato ground. The balance comprised 57 acres clover stubble, 5 of which had been pastured closely throughout the season and two cuttings removed from the remainder. The barley and wheat stubble grounds both possessed good stands of clover.

On October 4th, 11 yearling steers, 8 Jersey heifers, 3 colts and 25 pigs were given access to the fields. And on October 15th 230 lambs were added. This stock continued on the fields until November 15th.

The 11 yearling steers were put on the fields at a weight of 8,613 pounds, averaging 783 pounds. They were removed to the feed yards on November 15th, weighing 9,060 pounds, with an average of 823. During the 42 days, these steers required 3,344 pounds hay, because of frosts and storm, in addition to the waste materials consumed. Therefore the 447 pounds gain made by the steers, at  $4\frac{1}{2}$  cents a pound, is worth \$20.11, which sum, minus the hay consumed, viz.: 3,344 pounds at \$6.00 per ton, gives a profit of \$10.08 gain from the steers, from increase in weight, in addition to food required for maintenance.

The 230 lambs went on the fields on October 15th, weighing 11,699 pounds with an average of 50.86 pounds. On November 15th these were removed to the feed lots, after having weighed 13,948 pounds, averaging 60.64 pounds. We therefore have a total increase of 2,249 pounds of mutton, or 9.78 pounds per head. The increase of 2,249 pounds, at 5 cents, gives a return of \$112.45, minus 1,100 pounds clover hay at \$6.00 per ton, leaving a clear profit of \$109.15 from the lambs consuming waste farm products.

The 24 pigs, consisting of Berkshire and Poland China sows and young stock, were turned on the stubble fields on October 4th. They then gave a total weight of 2,731 pounds, averaging 113.79 pounds, including all ages.

On November 15th, these pigs were prevented from securing further supplies from the fields by severe weather. They were then found to weigh 3,608 pounds, an increase of 877 pounds over the weight at the time of going on the stubble. During this time 410 pounds of barley meal, at 60 cents per cwt., was fed in time of storm, amounting to \$3.28. The 877 pounds gain, at  $5\frac{1}{4}$  cents per pound, gives a return of \$46.04, which sum minus the value of the food fed, amounting to \$3.28, leaves a clear profit of \$42.76 from the 25 pigs while consuming waste grain. And this is, of course, over and above the food required for maintenance.

We regret that data was not secured relating to the colts and and Jersey cattle.

From a financial standpoint, a clear profit of \$161.99 was obtained from the cattle, sheep and swine, as follows: \$109.15 from 230 lambs, \$10.08 from 11 steers and \$42.76 from 25 pigs.

Nor is this all, for no account is made of the value of the waste products secured and used for maintenance of the animals. We have considered only the value of the actual pounds of flesh produced, and have also given credit for the supplementary food used.

Attention is called to the percentage rate of increase, in pounds, of cattle, sheep and swine feeding on waste materials, including the supplementary foods fed. As the original weight of the steers was 3,613 pounds, and 447 pounds increase was made, the percentage rate of increase was 5.19 per cent. The original weight of the lambs being 11,699 pounds, and the increase made 2,249 pounds, the percentage rate of increase was 19.2 per cent. In the case of the swine an increase of 877 pounds was added to the original weight of 2,731 pounds, giving a percentage increase of 32.1 per cent. The 3,344 pounds of hay fed to the 11 steers was just sufficient to supply their needs 12 days out of the 42; the 1,100 pounds of clover fed the 230 lambs during the month was used during a stormy period of 2½ days. The 410 pounds barley meal was required by the pigs during a similar stormy period when they were off the fields. In the case of the lambs the hay fed would not account for more than 100 pounds increase, and the grain fed to the hogs not more than 70 pounds.

These results show conclusively that sheep and pigs, both being close feeders, are better able to recover the waste products of the farm than cattle. And that the three can be used together to best advantage. That under the conditions described, steers are enabled to maintain themselves for a long period, but the gains will not be great. While the pig secures most of the fallen grain, the sheep, with appetite suited to a limitless variety, gleans from all sources alike, securing grain, grass, weeds and late pasture growths.

The sole benefit is not derived entirely from a monetary standpoint, but from the most thorough cleaning which the farm receives, especially from the sheep, which does the work of the scavenger in handsome fashion. They more than pay their way by the weed seeds which they destroy. There are few plants that the sheep will not eat if allowed access to them before they become dead and woody. And any weed seeds consumed by them do not

escape being destroyed. While the pigs secured their food mostly from shattered peas and wheat, the lambs consumed all classes of waste grain and vegetation. During the time the stock was on the fields 55 acres of the tract was plowed, as late as possible, for spring sowing beginning first with those possessing least food.

Where clover can be grown, sheep can be used most advantageously in gathering the waste products of the farm. Coming from the scant range they are thus prepared to go on winter feed in good form. Strange to say, no losses have occurred during two seasons from sheep and lambs grazing on frozen pastures, even though death from bloating has caused serious loss earlier in the season. This experience, with regard to late grazing on clover, is also supported by that of others in the valley. Contrary to eastern experience our clover pastures come out in better form in the spring when grazed off late in the fall. Luxuriant growths remaining on the fields seem to cause smothering or winter killing. The fields are also benefitted by the return of much fertilizing material.

As the result of utilizing the "waste products" of 112 acres on a Montana farm, by the means of live stock, we have a clear profit of \$161.99 or \$1.44 per acre over and above the value of the food secured by the animals and required for maintenance. And And these profits resulted practically without any expenditure for labor. If all the waste products of western farms were thus utilized they would become a source of revenue of great magnitude. The best financial successes result from securing all the revenue obtainable from these apparently worthless and insignificant sources.

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### FATTENING LAMBS ON CLOVER IN GALLATIN VALLEY.

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The Gallatin valley has long been famous for the production of brewing barley, wheat and oats, of unsurpassed quality. The conditions giving rise to such favorable results have been known to find their source in a deep, rich, easily worked soil, with an abundance of water for irrigation, and climatic conditions which

bring all the forces of nature into harmony in the perfect development of these products. But while the production of these grains is unsurpassed, both in quantity and quality, the same conditions which favor their growth produces marvelous results in the production of clover. As the result of experiments along this line, the Experiment Station has secured much valuable data relating to the growth of clover, its effect on the fertility of the land, and utility as a food factor. These facts will appear in future publications. And while the Station most earnestly advocates the growth of clover in Gallatin valley, the constantly increasing area has lead to another important question, viz: The most economic use which can be made of clover in order to secure the greatest possible return from it.

Two years ago experiments were conducted in lamb feeding, in which alsike, red clover, and alfalfa were the chief foods used. Careful comparison showed these three to possess feeding value in the order named, though with slight differences in any case. So that, what hereinafter is said of red clover, and its feeding value will apply much the same to alsike and alfalfa. During the last winter season, comparative results were obtained from the fattening of lambs on clover alone, with those receiving both clover and grain. These results have been so satisfactory, both by way of quantity and quality of product and financial return, that as the harvest season of 1900 closes, with innumerable clover stacks dotting the valley, we feel that the results of our work may at least offer some suggestions regarding the use of clover in mutton production.

On December 12th, 1899, 60 lambs were started on a 90 day feeding test. These were divided into three lots of 20 each; lot (1) received clover and wheat, lot (2) clover only, and lot (3) clover and oats. Within this period of 90 days, the lambs feeding on clover alone, consumed an average amount of 3.16 pounds per head, per day. The two lots receiving an average of .93 pounds wheat and oats respectively per head each day, consumed only 2.14 pounds clover.

The gains made during the 90 days were as follows: Lot (1), fed clover and wheat, 30 pounds each; lot (2), clover only, 24.3 pounds; lot (3), clover and oats, 31.75 pounds each. Considering

the fact that nearly a pound of grain was fed to each lamb, per day, to two of the lots, the showing made by clover alone is remarkably good. With lambs of the range type, feeders seldom reach a gain of ten pounds per head, per month, when both hay and grain are used. The two lots receiving grain and clover also had a slight advantage from the use of a small allowance of roots.

**Cost of Feeding.**—The clover hay was charged up at \$6.00 per ton, damaged wheat at 40 cents per cwt., and oats at 90 cents per cwt. At this rate the cost of food for each of the three pens of 20 each, for 90 days, was as follows: Lot (1), clover and wheat, \$19.38; lot (2), clover only, \$17.21; lot (3), clover and oats, \$27.95. The total gains per ton, in order, above given, were: Lot (1), 601 pounds; lot (2), 486 pounds; and lot (3), 635 pounds. Considering these gains, and the cost of foods, the clover and wheat ration produced mutton at a cost of \$3.22 per cwt. increase, clover alone \$3.54, and the clover and oats \$4.30. These results show conclusively that, though clover alone did not give absolutely the most rapid or cheapest increase, still, there was little difference between it and the clover and wheat ration, and that satisfactory gains and financial returns can be obtained from the clover alone. They also show that oats at the price charged, cannot be profitably used except in small quantities.

The profits derived from these three methods of feeding, at the end of 90 days, were:

Net profit per head, from lambs fed clover and wheat..	96 cts.
“ “ “ “ “ “ “ “ only.....	82 “
“ “ “ “ “ “ “ “ and oats.....	62 “

The lambs were bought at \$3.00 each and sold at the rate of \$4.68 per cwt., live weight. We conclude from the results of No. 1, that cheap grains, otherwise unsalable, can be used to good advantage along with clover for fattening lambs, and also, that while the clover alone gave good results, we believe that where possible a small amount of grain fed with it, will increase the gain and add to the quality, but large quantities are not necessary with the quality of clover here produced. From the data obtained it was found that 11.8 pounds of clover was required to maintain the animal and produce a pound of gain. Thus one ton of clover produced 169.5 pounds of mutton, which, at the selling price of

\$4.68 per cwt. was worth \$7.93. Is this not a good market value for one ton of clover hay? Is it possible to dispose of it to better advantage in any other way?

The necessity of securing the proper type of lambs for feeding is very important. During the past two seasons, comparative results have been secured by feeding lambs of the mutton type, and wool producing kind by similar methods. Those of the mutton type used, contained a large percentage of Shropshire blood. They were large framed and strong boned, cylindrical of form, possessing broad evenly fleshed backs, with good width at brisket, chest, and shoulders. The other class, composed of Merino grades, were almost the reverse as to general form and quality. The compact lamb, of the former class, carrying a large quantity of natural flesh, when fed on an expensive ration of clover and oats, produced 100 pounds gain at a cost of \$4.39 per cwt., while those of the inferior type, using the same kind of food, in the same amount, cost \$4.65 per cwt. increase. The lambs of the mutton type required over one-half pound less clover to each pound of increase.

The results obtained lead us to conclude that, with the conditions which Gallatin valley presents, the possibilities for mutton production are unparalleled, for in the first place, the best foods can be grown abundantly, and secondly, we have the stock near at hand to consume it. Individual acres of clover, grown at the Experiment Station, for three successive years produced over one and one-half tons of hay, at from 119 to 133 days from date of sowing.

During the season just closed, a field of 7.26 acres produced, at two cuttings, a total of 35 tons 1,451 pounds of well cured clover hay. And while this food can be produced in such great abundance, it has the advantage of possessing a large percentage of those nitrogenous compounds or flesh formers which the eastern feeder, who relies chiefly on corn or screenings, cannot buy. The clover produces a much better quality of meat than the starchy foods, such as screenings, corn, barley, etc., and this will apply to beef and dairy productions as well.

While the production of clover, and its conversion into mutton is desirable, this need not interfere with the grain output. On the contrary, clover must materially assist the grain producer, taking

the place, as it is, of the vast summer fallow area. We therefore have the clover for feeding purposes without decreasing the grain area.

The question of the disposal of finished mutton is one which confronts us in a serious way, as the local demand does not require but a limited quantity. It is the purpose of the Experiment Station to fatten a car load each of lambs and steers, for shipment to Chicago in the early spring. Several others have also signified their intention of feeding in time to join this experimental shipment. We have found that it will pay to feed lambs from 70 to 90 days and steers at least 120.

Results justify conclusions to the effect that mutton can be successfully produced on clover alone, though the use of a small grain allowance is desirable especially because of its ultimate effect on quality. Where clover or alfalfa may have been damaged and unsaleable, it cannot be used in a better way than as a sheep food. We cannot urge too strongly the growth of clover in Gallatin valley and its subsequent conversion into mutton.

What has been said of the clover and Gallatin valley conditions, will apply in much the same way to the numerous alfalfa regions of Montana.

## CHEMICAL DEPARTMENT.

F. W. TRAPHAGEN, Chemist.

The usual lines of work have been carried on by this department during the past twelve months. A considerable amount of time was given to an examination of the condition of the foods found in our market and a resumé of the results is introduced here. A detailed report of this work has been published in the Biennial Report of the Bureau of Agriculture, Labor and Industry.

Much interest has been manifested in this work and numerous newspaper articles have been written, and addresses given in an effort to better conditions by arousing public sentiment and securing the enactment of proper legislation for the protection of our citizens. Through the efforts of Senator Hoffman a bill was introduced into the legislature at its last session and its passage through the Senate secured. The activity of a lobby of grocers, mainly from Butte, caused the defeat of the bill in the House of Representatives, not, however, without the disapproval of a large number of our best citizens.

It is to be hoped that funds will be found for the purchase of another series of samples to be used as an object lesson in another campaign for protection.

### RESULTS OF FOOD EXAMINATION.

	Found Adulterated.	Not Found Adulterated.
Canned Vegetables.....	6	25
Soups.....	5	9
Tomato Catsups.....	12	0
Jams, Jellies and Preserves.....	26	0
Cereal Breakfast Foods.....	0	30
Baking Powders.....	9	6
Flour.....	0	18
Miscellaneous Foods.....	15	13
Vinegars.....	21	6

The sugar beet investigations of the past season have not been at all satisfactory. Because of changes in the administration of this part of our work, seed was not sent out sufficiently early to secure active co-operation on the part of our farmers and very few reported having planted.

This season we have projected the most general test yet carried on, and every agricultural section of the State will be represented in the trials. The seed has been sent out sufficiently early to secure the benefit of planting as soon as conditions permit and the results should be of considerable value.

On the Bitter Root Stock Farm, near Hamilton, Mont., the most systematic series of experiments, yet made within the State, are being carried on. Small tracts selected at different points on the farm have been chosen, affording a great variety of soil and conditions. Sugar beets are being grown on these plats under the direction of a skilled sugar beet culturist from Utah, and will be handled far better than they ever have been in this State. Heretofore the crop has been grown incidentally, usually merely as a favor to the Experiment Station, and has received attention when everything else has been looked after. While we greatly appreciate the assistance we have received from co-operating farmers, it is no less true that sugar beets have been greatly neglected in the past and the excellent results previously obtained have been in spite of very unfavorable conditions.

Besides the tests above mentioned, through the efforts of Hon. W. A. Clark, seed has been widely distributed throughout the valley of Clark's Fork of the Yellowstone river, and a new field will be studied here. There is little doubt that, if the results of the present season are satisfactory, a beet sugar factory will be established at some point within the State. This means much, not only to the favored community, but to the State at large.

In connection with our study of the alkali problem we have been making a series of experiments to determine the limit of tolerance for alkali of our different crops. These tests have been very satisfactory and serve to show that there are very few places in our State where the alkali alone is in sufficient quantity to prohibit the growth of our usual crops. A number of interesting points have been noted in this investigation, which will be pre-

sented in a bulletin soon to be issued. Successive series of experiments have been planned with various plants, which, taken in connection with our analysis of the soil of different sections, will enable us to prescribe the crop most likely to succeed in any instance.

Pot experiments have been instituted to determine the best methods of handling such soils as resist ordinary methods of treatment. The effects of tailings and tailings waters from the copper smelters, upon hay and grain crops, have been carefully studied and the results will be embodied in a bulletin to be issued soon. It may be said that the conclusion was reached that chemically there has no evil resulted from the presence of metals in solution and that the mechanical effects are the same as would come from the presence of the same amount of sand or clay under similar conditions.

A resume of the analytical work shows the following as the work of the year:

Soils .....	285
Foods .....	201
Water .....	10
Milk, etc. ....	4
Butter .....	12
Beets .....	7
Coal .....	8
Miscellaneous .....	36
Total. ....	563

## BOTANICAL DEPARTMENT.

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J. W. BLANKINSHIP, Botanist.

The work of the botanist during the past year has been confined chiefly to a study of the weeds of the State and the preparation of a summary of our knowledge of the same, issued as Bulletin No. 30 of this Station, and a continuation of the study of the plants poisonous to stock and the conditions under which that poisoning usually occurs. Unfortunately the field work could not begin until June 1, after the main period of poisoning was over, so that relatively few cases could be investigated immediately after the poisoning occurred. Nevertheless, through the co-operation of the various railways traversing the State, a large amount of data was accumulated and the distribution of the plants chiefly concerned was largely determined.

In addition to this work a considerable number of plants sent in for identification have been determined and more than a thousand specimens have been added to the herbarium, among which was a set of the grasses of the United States from the Division of Agrostology at Washington.

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### A NATIVE HEDGE PLANT.

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Hedges are desirable in every country not only for their permanent utility in fencing yards and fields, but also for their ornamental value. As yet no plant has come into general use in Montana for this purpose, but a series of independent experiments

have been made in various parts of the State to utilize the buffalo-berry shrub (*Shepherdia argentea*, Nutt.) for this purpose, and, while not fully successful, the results seem to show that with proper care the plant can probably be made to answer the purpose.

*Shepherdia argentea*, Nutt. grows in the lowlands along streams throughout the Great Plains region from Manitoba and Kansas westward to the mountains and in the Great Basin to the Sierra Nevada range. In Montana it is found in more or less abundance east of the Divide, along the Missouri, Yellowstone and their tributaries, often forming dense impenetrable thickets in the lowlands. It is a shrub, or small tree, rarely exceeding 25 feet in height and a diameter of 5 or 6 inches, with widely spreading, tough and thorny branches and bearing a dense cluster of pale red, rarely yellow, berries, ripening in autumn and having a sharp acid flavor, esteemed for jelly-making, for which they are extensively used.

Although the plants grow naturally only in the low ground, there is no reason why they should not be made to grow wherever the roots can be kept moist by irrigation in the plains or valleys in any part of the State. The following gentlemen give the results of their experiments with the buffalo-berry plant for the benefit of others who may care to continue the work.

Mr. John Matheson, living 8 miles east of Chinook in the Milk river valley, writes (December 21, 1900) as follows:

"The buffalo-bush hedge was planted three years ago as an experiment and seems to answer the purpose. It grows in alkali land, stands the climate and bears trimming. It is not a very fast grower and it will take about 6 years before it can be depended on for a fence. I tried to grow the plants from the seed, but failed, owing to the place being flooded in the spring. The plants should be reset, when not more than six inches high, in a double row about twelve inches apart each way. The cost of such a fence will not exceed 50 cents a rod. The Osage orange will not grow; I tried it and failed."

Mr. Olney Taylor, of the State Board of Horticulture, has performed a similar experiment at Park City on the Yellowstone and gives his conclusions (November 12, 1901) as below:

"In regard to the buffalo-berry as a hedge plant I will say that my experience with it is rather limited. A few years ago I planted some seeds along the road, which grew well and, if they had been properly pruned, I think would have made a good hedge, but they have been allowed to grow naturally and are tall and not as thick as they should be. The greatest objection I have to them is that they sprout quite badly where the ground is cultivated near them."

Mr. A. M. Crawford, of Billings, is another who has tried the plant for this purpose and writes under date of November 13, 1901:

"The buffalo-berry makes a beautiful and effective hedge. The land should be in good tillable condition before planting. If new ground, a strip about four furrows wide and two furrows deep—as deep as the plow can be made to run—should be prepared in the fall for early spring planting. While the buffalo-berry is native along our river bottoms, I find that the young plants can be readily established on uplands, but with difficulty on low, soggy ground; and that, while in the former position they must be carefully irrigated, in the latter they are likely to get in a way troublesome brush. One more weaving and you have a hedge that cattle, and even boys, are willing to let alone. From this time on it is a question of neatness and the pruning shears. The work of weaving can be greatly facilitated by having smooth wires at stated intervals under which to bend the young wood."

The buffalo-berry will not grow in the foothills above 3,000 feet altitude, but it may be possible to utilize the black and red haw (*Crataegus coccinea*, L. and *C. Douglasii*, Lindl.), which take its place in those situations and grow in abundance. For ornamental hedges the barberry (*Berberis Canadensis*, Push and *B. vulgaris*, L.) and the privet (*Ligustrum vulgare*, L.) may well be employed as they are perfectly hardy in most situations below 5,000 feet and have been grown successfully in the gardens of the Station at almost that altitude.

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THE "ARCTIC BERRY" FRAUD.

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For a number of years a man, with a camping outfit, has been canvassing various parts of the State selling a so-called "Arctic berry," taking orders throughout a particular section during the spring and summer and delivering the plants in the fall. He exhibits a number of the "berries" preserved in a liquid in a bottle and they are said to have a very attractive appearance, being "three times the size of a strawberry and with the color of an orange." He claims the fruit is of his own production, resulting from crosses between a number of berries of which the huckleberry, sarvice berry, strawberry, wild cherry and several other unnamed species, play a part, the whole combining to form the wonderful fruit then exhibited. He claims the fruit was first grown by himself in Idaho, and is now cultivated successfully in the Gallatin valley, near Bozeman. From reports it seems that this plausible gentleman has "worked" a great part of the State, including the region about Great Falls, the Gallatin valley and the Madison river and spent the summer of 1901 in Sweet Grass and Carbon counties. The matter was called to the attention of the Station in time to advertise the fraud in the newspapers before the delivery of the "berries" and relatively few were disposed of. It was then stated that any man knowingly making such statements as those attributed to him in regard to the origin of the fruit in question, was a fraud and subject to prosecution under the laws of the State, and he was asked to submit some of the fruit and plants to this Station that we might pass upon the value of this remarkable hybrid. Notice was also given in all the Bozeman papers for information in regard to this new plant, from anyone cultivating it in this vicinity, but no responses have been received either from the agent or from any successful grower, for all the plants sold in this vicinity are either dead or killed down each year by the frost, and we have yet been unable to secure living specimens for examination. Horticulturists, who have seen the growing "Arctic berry," report the plant sold as the white mulberry (*Morus alba*, L.) and some leaf-scrap examined seem to agree with that species. The thing is a palpable fake, for such crosses as those mentioned

are botanically impossible. Space is here given the subject in order to protect the people of the State from such imposition hereafter, and to warn our neighbors of adjoining States to look out for this smooth-tongued "nurseryman."

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### POSSIBILITIES OF STRAWBERRY CULTURE IN THE STATE.

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In a state with great variations in climate, due to the difference in altitude found in mountainous regions, it is possible to extend the fruiting period of seasonal fruits, such as the strawberry, over considerable time by taking advantage of this progress of season at the different altitudes, and this fruiting period may be still further extended by planting early and late varieties. As far as can be yet judged by the native vegetation, there appears to be a difference of about a week in the opening of flowers and the ripening of fruit for each 2,000 feet of altitude and as our altitude ranges from about 1,800 to over 11,000 feet, it seems that advantage might be profitably taken of this fact for growing a fruit for which there is always a ready market.

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### THE ALKALI DISEASE OF PLANTS.

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Several times recently my attention has been called to a supposed parasitic disease affecting plants in certain localities, but upon examination no fungus was found, but the plants had every indication of poisoning by alkali, either through the rise and settling in low ground of the waters of irrigation containing these salts in excess, or through watering potted plants with such water. In general, plants thus affected show it by the gradual yellowing of the foliage, or by the withering of the leaves at tips and edges, until they die and drop off, causing the death of the plant. A considerable number of the trees in the park along the river side, at Great Falls, appear to have died from this cause and the same trouble has been found with shade trees in certain localities at Helena and Bozeman. The remedy in such cases is clearly

underground drainage to carry off the excess of salts accumulating in the water in such situations, or a reduction in the irrigation on the higher ground near by. The trouble seems also to affect potted plants and gardens, when watered with water containing an excess of alkali, and cases have arisen seemingly from this cause at Columbia Falls and Helena and will doubtless be noted from other localities in the eastern part of the State, the remedy here being to secure water from some source not thus contaminated.

The effects of alkali upon plants are thus described by Dr. E. W. Hilgard, director of the California Experiment Station: "In the case of herbaceous plants the first effect is a dwarfing of the whole system, and as the salts accumulate at the surface, they will cause a corrosion of the root-crown. In the case of trees also the root-crown usually shows a darkening of the bark, and a browning of the liber, if the alkali is strong enough. It is then that the leaves yellow, but short of such an effect upon the root-crown the essential symptom of alkali plants is a dwarfing."

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#### INVESTIGATIONS OF PLANTS POISONOUS TO STOCK IN MONTANA.

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This work, begun during the preceding summer has been continued for most of the present season, but has been confined mainly to field work to determine the plants causing the various cases of poisoning reported, the times of the year when such poisoning is most apt to occur with the conditions then prevailing and the localities in the State found to be most dangerous to stock, with the reasons therefor; also, to determine the distribution over the State of the plants known or suspected of causing this poisoning and to devise methods for avoiding the same, as far as possible. The work of experimentation to ascertain the exact effects of suspected plants upon animals has been left, by agreement, to the specialists of the Department of Agriculture, who are conducting their work at this Station during the present summer.

In order to call the attention of stockmen to this work and secure their assistance in conducting the same, the following circular was issued:

**NOTICE TO STOCKMEN.**

The Montana Agricultural Experiment Station in co-operation with the Department of Agriculture at Washington and the State Veterinarian at Helena, is attempting during the present season to make a study of the plants poisonous to stock in this state. In order to fully determine the conditions under which the poisoning normally occurs and the plants to which it may be referred, it is desired that detailed reports be made to this Station of losses now occurring, as well as any losses which may have occurred in the past, noting, as far as practicable, (1) the exact locality in the State in which such poisoning occurred and the local conditions, whether lowland or upland, plains, foothills or mountains, about springs or along streams; (2) the time of the year of such poisoning; (3) stock affected, whether horses, cattle or sheep; (4) the number poisoned, their symptoms and treatment pursued, as well as relative proportion of deaths; and (5) the plants suspected, with descriptions or specimens. It is only by the compilation of such data that the dangerous zones in the State can be accurately determined, as well as the time when they must be avoided.

By the co-operation of the stockmen of the State in this work, particularly in reporting promptly for investigation, all new cases of poisoning that may occur, it is hoped that definite results may be secured and the present loss due to this cause prevented.

Address all communications and specimens to, MONTANA AGRICULTURAL EXPERIMENT STATION, Bozeman, Montana.

June 5, 1901.

The results of this investigation will be issued as a bulletin early next spring in time to be of service to the stockmen during the dangerous season.

In order to make this work as practical as possible, the Station has had sets of the plants, suspected or known to be poisonous, mounted and framed for general distribution in the principal stock-growing centers and these will be sent to anyone who will pay the expense of framing and transportation and agree to place them on exhibition in some public place in his locality. A number of these frames have already been distributed. It is hoped that next season portfolios can be prepared of the most dangerous species for distribution to stockmen to be placed in the hands of their foremen and herders to make known the plants, which must be avoided or destroyed, but at present not enough specimens have been collected to enable this to be done, except in a few cases.

## ENTOMOLOGICAL DEPARTMENT.

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R. A. COOLEY, Entomologist.

An account of five insect pests, not previously mentioned in the publications of this Experiment Station as being present in Montana, is herewith presented. All are of first-class importance, some having proved themselves very injurious to our vegetation and the others being well known for their destructive habits elsewhere.

The year's experience has emphasized the importance of the entomologist's being about the State as much as possible in order that the presence of injurious insects may be detected and made known. The widespread belief in Montana that injurious insects have not yet found their way to our fields is only partially based on facts, but is due, rather, to a lack of knowledge of the real conditions. It seems clear, then, that the actual conditions should be published as rapidly as possible so that the fruit grower and rancher may not, through ignorance of their presence, allow them to gain a foothold. The past year has developed a knowledge of the presence and distribution of a considerable number of very important pests and there can be no doubt that the coming year will reveal many more.

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**THE STRAWBERRY LEAF-ROLLER.**

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*Phoxopteris comptana.* Frol.

So far as is known to the writer the strawberry leaf-roller has not yet been very destructive in Montana, but for many years the species has been fairly well known in other parts of the country and in some localities has been exceedingly destructive. In Washington it is looked upon as being the most destructive pest affecting the strawberry in that state. We therefore have reason to fear that in a few years we too may suffer from its ravages. It has been discovered in Helena, and has been reported from Miles City.

The insect feeds upon strawberry, blackberry, raspberry and various other plants.

It receives its name from its habit of rolling and crumpling the leaves of its host-plant. The larva, which is small and of a greenish color, lives within the rolled or crumpled leaves where it feeds from the inside. When abundant, the larvae not only devour the foliage but cause it to turn brown. They are very active and when taken into one's hands will quickly wriggle out and drop to the ground. There are two broods of the larvae each year, the first brood appearing in June and the second in August. The parent moths are very small and of a reddish brown color.

The best remedy to be employed is to cut the vines after harvesting the crop, and, after allowing them to dry burn them as they lie. If there are not enough vines to burn well some old hay or straw may first be spread over the field. No harm will be done to the vines by burning in this way.

If it is preferred the vines may be sprayed after harvesting the crop. The insecticide used should be arsenate of lead in preference to Paris green since it remains on the foliage very much longer. This insecticide has a distinct advantage for this pest since, remaining so persistently on the foliage, will be rolled by larvae into the leaves where it is needed.

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### THE NATIVE CURRANT SAW-FLY.

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#### *Gymnonychus appendiculatus.* Hartig.

This insect was very destructive to gooseberries and currants during the year in the vicinity of Kalispell, showing preference for the first named fruit but entirely defoliating currants also. The species also occurs in Miles City and like many other pests probably exists unrecorded in other parts of the State.

The larvae are pale green even when full grown and lack the black spots found on the larvae of the European relative of similar habits, which is very common in the United States.

The adults are four-winged fly-like insects, black in color with yellow markings. Two broods of the larvae occur, one appearing late in June or early in July and one in August.

White hellebore, either dusted on the foliage while the latter is damp, or sprayed in water at the rate of one pound in twenty-five gallons, is a good remedy.

The hellebore should be secured in advance since when needed it may not be found in sufficient quantity.

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### THE CABBAGE LEAF-MINER.

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#### *Plutella cruciferarum.* Zell.

The cabbage leaf-miner is a European pest which has been imported into this country and has become widely distributed. In Montana it is known by the writer to occur at Hamilton, Bozeman, Missoula and Miles City. It has doubtless been brought into the State on cabbage heads intended for consumption.

The species occurs on the leaves of cabbage and related plants as small green worms, one-fourth of an inch long, tapering toward both ends and having the head yellowish. When ready to transform the larva spins a delicate gauze-like cocoon of white silken threads and the enclosed pupa may be readily seen through the silken case. The moth is about three-quarters of an inch long,

with gray, white, black and brown markings. Three diamond shaped spots on the back of this long, slender and shy moth make it easily recognized.

Spraying the affected plants with water is said to be a good remedy. The insect thrives only in dry weather. Pyrethrum insect powder has given satisfactory results. The larvae often co-exist with the cabbage aphid, discussed below, and are readily destroyed by the substances used in controlling that pest.

### THE CABBAGE APHIS.

*Aphis brassicae*. Linn.

A great many fields of cabbage and related plants were wholly or partly destroyed during the year by this species and a large number of letters concerning it were received and answered. The insects were present in almost incredible numbers completely covering all parts of the plants and working into the heads of cauliflower in such numbers as to destroy their value. Affected plants withered and appeared as if suffering from dry weather.

The real color of the lice is greenish gray, but this is obscured by the waxy or mealy secretion which covers their bodies and gives them a leaden color.

The species attacks cabbage, turnip, cauliflower, rape and other plants of the same natural family (*Cruciferae*).

As a remedy for the pest, kerosene emulsion, one part of the emulsion in ten of water, or whale-oil (more correctly fish-oil) soap one pound in fourteen gallons of water, may be used.

The insects readily succumb to these substances, the only difficulty in the treatment being to get the insecticide in contact with all the lice.

The lice cover both surfaces of the leaves thereby making it necessary to spray the under as well as the upper surface. The spray-nozzle must be lowered among and under the leaves. It may, if desired, be fastened to the end of a piece of half-inch tubing which will allow the operator to stand erect.

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THE ROSE CURCULIO.

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*Rhynchites bicolor.* Fab.

This insect is generally distributed throughout the United States and while having been seen by the writer only at Bozeman, Missoula, Hamilton and Kalispell, in Montana, it is almost certain that it occurs in all parts of the State.

The rose curculio is a beetle one-fourth of an inch long, red over the entire upper surface from the head to the tip of the abdomen, with the ventral surface, beak or snout, antennæ and legs black.

It affects both wild and cultivated roses, boring by means of its long snout into the buds and cutting the stems causing the buds to lop. It is particularly destructive west of the range where roses are grown more readily than on the east side.

Great injury to roses is caused by this species. It takes very much the same place that the rose chafer (*Macrodactylus subspinosus*) occupies in the east.

No very satisfactory remedy is known. The writer is making observations on the habits of the species and hopes to find some means of defense against it.

Temporary relief may be secured by hand picking or by drumming them off into a pan of kerosene, or kerosene and water.

## SUB-DEPARTMENT OF POULTRY.

H. C. GARDINER.

Student in Charge.

During September, October, November and December 1900 three pens of fowl were fed separately, with a view to determine the best method of feeding and caring for hens during the moulting period. While this work was not carried far enough for conclusive results, we would from the results obtained, advise a liberal ration for moulting hens, and attention early in the fall. It was found that flax seed was a valuable addition to the ration, and that a full ration tended to stimulate the growth of feathers.

Although we must depend chiefly upon early hatched pullets for winter eggs, still it is an additional source of profit if the year old and two year old hens can be made to contribute their share to the egg-basket. In order to secure these results fowls must be fed liberally commencing in September, in order to hasten the moulting of those who have begun, and to start those whose low condition, resulting either from rearing a brood of chicks, or laying late in the summer, has left them without vigor enough to moult before cold weather. Owing to this general low condition which follows the summer's work the flock may not respond readily to their feed, and it is advisable to stimulate and tone the digestive system with Cayenne pepper, assafoetida, etc., and give "Douglas mixture" in their drinking water twice a week. Douglas mixture consists of four ounces copperas, one ounce sulphuric acid in two gallons of water, using it in the proportion of a tablespoon in a quart of drinking water twice a week. Such precautions will to a great extent fortify the bird's system against roup and colds which occur so generally in this State in the fall and winter months.

During the past year we have received many inquiries about how to treat flocks which are affected with roup and colds, and we have advised maintaining all stock in a vigorous condition in order that they may successfully withstand our broken fall and

winter weather. Debilitated animals are the most susceptible to diseases of any kind, and improper quarters and poor feed only add to the danger. In order to secure freedom from roup the houses must be dry, free from draft, of reasonably even temperature and well ventilated. Frame houses are best because they are easily kept dry, and we believe that it is a mistake to construct poultry houses of stone or concrete, as the walls of such buildings are almost invariably damp, and fowls kept in such buildings are particularly liable to disease. In order to maintain an even temperature all chinks and cracks should be kept closed and the building made as tight as possible, with a window space of about one-eighth of the front in a building six feet high. Too large an area of glass causes the building to heat very quickly during the middle of the day, while at night it affords a large radiating surface, chilling the interior and producing catarrh and colds among the inmates. This difficulty may be overcome best, by the proper glass area, and by the use of a stove on cold nights and during long cloudy spells. Last, but not least, comes the ventilation question, while a building should be built as nearly air tight as possible, it should also be well ventilated. Nothing poisons the animal system more quickly than impure air laden with gases exhaled by the fowl, and arising from the droppings. These gases being naturally heavier than the air settle in the lower portions of the house, and it is from these lower levels we must ventilate. Ventilators opening at the roof are inefficient; while they may remove a portion of the lower body of air, they remove chiefly the upper portion which is warm and pure and which should be retained. To thoroughly, cheaply and easily ventilate, run a common six-inch stove pipe from the roof to within six inches of the floor, having a damper in it at a convenient height. The warm air near the roof warms this pipe, which in turn warms the air inside, and this enclosed air rising creates a draft which gradually and successfully removes the impure air in the vicinity of the fowl. We believe if the many inquirers and others, whose flocks are affected, would follow these directions, this disease which is so prevalent throughout the State would soon become checked.

During January, February and March another feeding experiment was conducted in which six pens, comprising 90 birds in all,

were fed to determine the feeding value of three of our most widely grown grains, wheat, oats and barley, and further what advantage is to be gained from mixed grain rations. Although this work will be continued further before any definite conclusions are drawn we believe that oats and wheat is the most profitable mixture and wheat is the most desirable to feed alone.

The department also published a bulletin designed to meet the needs of beginners in this branch of farming, which discussed the following topics: Breeds of poultry best suited to Montana's market and climatic conditions, artificial incubation and the care of incubator chicks, general management of breeding stock and laying birds, advantages of pure-bred stock, construction and ventilation of buildings, construction of brooders and brood coops, incubator oils, and egg-preservation. The results of feeding experiments which were planned to show the necessity of variety rations in egg production were also given, together with data relative to the effect of these different rations upon egg fertility, and upon the composition of the egg.

During the winter months we were forced to keep several of the pens confined on account of lack of yards, the ground about the building being only partially graded. We found as a result of this confinement that even with careful precautions the vice of egg eating developed to a very considerable extent among the hens, and cutting the beaks was only a temporary check. Darkening the nesting place also had no effect, and at a loss to stop the practice by any specific means, we dug post-holes in the frozen ground with giant powder and erected temporary fences. This proved an effectual remedy, for as soon as the birds secured the run of the yards the practice ceased with the exception of one or two individual cases. This practice is evidently the immediate result of idleness resulting from close confinement and is best remedied by removing the cause of the evil.

The spring months were devoted almost exclusively to raising pure-bred chicks, and with the stock raised this year we have been able to replace all the old mongrel stock and culls, and now have for the first time all our pens filled with first-class breeding stock which adds much to the value and attractiveness of the department.

Numerous enquiries are received from time to time with reference to construction of buildings, feed of fowl, diseases, incubators, etc., all of which are answered as required.

## HORTICULTURAL DEPARTMENT.

CHARLES WILSON, Gardiner.

Temporarily in Charge.

### ORNAMENTAL SHRUB CULTURE.

In all fifty deciduous shrubs have been tested for four consecutive years. This year's work has confirmed the results of the three preceding years. Twelve varieties have been found to be hardy, nineteen semi-hardy and nineteen worthless.

#### HARDY.

*Berberis Canadensis*, American Barberry.\*

*Berberis Vulgaris*, European Barberry.\*

*Berberis Vulgaris purpurea*, Purple-leaved Barberry.\*

*Cornus Sanguinea*, Crimson Dogwood.\*

*Legustrum*, White-berried Privet.\*

*Ribes aureum*, Yellow-flowering Currant.

*Symphoricarpus racemosus*, White Snowberry.\*

*Syringa Caerulea Superba*, Lilac.

*Syringa Villosa*.

*Syringa Vulgaris*, Louis Spath.

*Syringa Vulgaris*, Princess Alexandria.

*Viburnum opulus Sterilis*, Snowball.

\*Those starred have had young wood slightly winter killed two or three seasons, but not sufficiently to interfere seriously with the progress of the shrub. The balance do not suffer in the least from the severity of winter weather, and will probably give good results throughout the State where the altitude does not exceed 5,000 feet.

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**SEMI-HARDY.**

*Berberis Aquifolia*, Mahonia.\*

*Elæagnus longipes*, Silver Thorn.\*

*Hydrangia paniculata grandiflora*.\*

*Lonicera Tartarica grandiflora*, Pink-flowering Honeysuckle.\*

*Lonicera Tartarica alba*, White-flowering Honeysuckle.\*

*Prunus triloba*, Double-flowering Plum.

*Pyrus Japonica*, Japan Quince, Scarlet.\*

*Pyrus Japonica*, Japan Quince, Blush.\*

*Rhus glabra laciniata*, Cut-leaved Sumac.\*

*Sambucus nigra aurea*, Golden-leaved Elder.\*

*Spiraea Van Houttei*.

*Syringa*, Garland.\*

*Syringa*, Golden.

*Syringa*, Large-flowering.

*Tamarix*.

*Viburnum*.

*Syringa rothomagensis*.

*Saulbucus nigra laciniata*, Cut-leaved Elder.\*

\* Young wood half kills back each winter. While this occurs under our local conditions there are more suitable localities in the State where these will answer well. Those not starred in this group do well here.

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**SHADE TREES.**

The Russian and Carolina poplars have given the best results being particularly hardy. The former is a fast grower, branching and symmetrical with large leaves. The yellow cottonwood follows these two closely.

Box elders, raised from seed, are hardy and growthy, but this does not seem to be the case with imported stocks.

Mountain ash has proved to be hardy and a rapid grower of good shape.

The ash, elm, English elder, maple and burr oak have proved to be worthless unless under very favorable conditions.

## ROSES AND FLOWERS.

Of the 28 kinds tried only two are hardy so that they can be grown without covering. These are the Persian yellow and Magna Charta. The former produces a great profusion of large yellow roses.

In the green houses 30 varieties of chrysanthemums and 20 of carnations have been propagated. These lend much attractiveness to the place and are a source of income as there is a great demand for them.

## EXPERIMENTS IN FRUIT CULTURE.

### APPLES.

The varieties given below have been set in the orchard most of them six years, and the balance four and five. The relative hardiness of these has now become a certainty and much more has been learned this year regarding their bearing capabilities and the quality of the fruit.

#### HARDY.

Anisette	Langfield
Bogdanoff	Number Twelve
Ben Davis	Orel
Duchess of Oldenburg	Okabena
Gano	Royal Table
Gipsey Girl	Thompson's No. 10
Good Peasant	Voronesh
Gideon	Wealthy
Hibernal	Yellow Transparent
Lead 3 N	Zuzoff

These kinds have all come into bearing with good results except for Orel, the fruit of which fell before maturity.

#### NOTES ON FRUIT.

**Longfield.**—Good yielder, medium size, medium early fall apple.

**Wealthy.**—Late fall or winter, big yielder, attractive fruit.

**Gideon.**—Late, large and attractive.

**Hirbernal.**—Good yielder of large greenish red fruit; winter.

## CRABS.

Bailey's Crimson  
 Florence  
 Greenwood  
 Hyslop  
 Martha  
 Orange

Pride of Minneapolis  
 Russet  
 Transcendant  
 Whitney No. 20  
 White Arctic

All these are now in bearing and may be classed as hardy except for Whitney and Orange.

Of these *Transcendant* was one of the most satisfactory, being early and yielding a large quantity of medium sized fruit.

*Whitney*.—Also produced well but is a little tender.

*Russet*.—Ripened early, fruit sweet and pear shaped.

*Hyslop*.—Has been a continuous bearer for three years, large quantity of medium sized fruit, but a little late.

*Bailey's Crimson*.—Good yielder, early and medium size.

*Martha*.—Good size, medium early.

*Pride of Minneapolis*.—Small, green, sweetish, medium early.

*Orange*.—Late and semi-hardy.

## PLUMS.

Of the many varieties tried, but one, the Moldorka, has succeeded in ripening fruit. Two trees of the same age came into bearing, producing 30 pounds of large blueish fruit which ripened by September 10th.

## STRAWBERRIES.

Of the large number tried in the original tests only five are recommended, viz.: Splendid, Bisel, Ivanhoe, Crescent and Bederwood. Of the 37 varieties of more recent introduction only two have been selected, the Wolverton and William Belt.

## RASPBERRIES.

The Marlborough, Hausel and Brandywine, only, have given good results under the local conditions. The former freezes back slightly, but yields well. The two latter are the hardiest and are good yielders of good quality.

Though the Clark and Gurner freeze back they produce moderately well, but the berries are soft and of little account.

Columbian, Early King and Cuthbert have been tried, but freeze down every winter.

## IRRIGATION DEPARTMENT.

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S. FORTIER, Irrigation Engineer.

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### ONE SOURCE OF WASTE IN IRRIGATION.

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In Montana, water for irrigation is conveyed for the most part through channels in earth. Ordinary earth is porous and will not retain water without considerable loss. When large volumes are carried in open canals over long distances the loss or waste of water from this one cause frequently exceeds one-fourth of the total flow. The percentage of loss varies in accordance with the physical conditions. In retentive clay soils the seepage loss is usually small. On the other hand when canals are located around foothills and over sandy and gravelly benches the loss is usually great.

In the absence of accurate measurements the loss in conveyance was not known. Irrigators were aware that much less water was available at their respective headgates than entered the main canal, but they attributed the deficiency largely to evaporation and absorption along the route. The water that seeped from the bottom of the canal could not be seen by the ditch rider and its effects were not always apparent on the land bordering the canal. The joint efforts of this Station and the Department of Agriculture in making a series of measurements on each of several typical canals in the State and publishing the results have directed general attention to the subject of the seepage loss from canals.

For two seasons the loss due to seepage on several of the large canals of the State has been ascertained. The following table gives in brief the principal results:

Date.	Total Flow at Head. Sec.-Ft.	Distance in Miles.	Loss in Sec.-Ft.	Percentage of total Supply Lost.
<b>Middle Creek Canal, Gallatin County.</b>				
June 10, 1899.....	98.9	4	21.5	21.7
" 27, 1900.....	63	4	12.2	19.4
<b>Farmers' Canal, Gallatin County.</b>				
July 30, 1900.....	133.1	10 <sup>3</sup> / <sub>4</sub>	23.59	17.71
<b>West Gallatin Irrigation Canal, Gallatin County.</b>				
July 18, 1900.....	114.45	38 <sup>3</sup> / <sub>4</sub>	38.93	34
<b>The Big Ditch, Yellowstone County.</b>				
August 9-13, 1900.....	254.47	22	65.05	25.55
<b>The Republican Canal, Ravalli County.</b>				
July 21 24, 1900.....	120.49	12 1-5	38.84	31.32

#### AN EQUITABLE DIVISION UNDER CO-OPERATIVE CANALS.

While enormous yields can be produced under irrigation the system is not without its drawbacks. One of these is the difficulty encountered in dividing water equitably among a large number of shareholders. In average years water is fairly abundant in this State, but owing to a light snowfall for two winters in succession the water supply has been deficient in many sections. The difficulty has been aggravated in not having proper headgates and measuring boxes. The division of water is usually based on the wild-guesses of the water master.

So long also as the loss in conveyance was not even approximately known it was impossible to give each user his proper share. The irrigation department of the Experiment Station has begun a good work in determining for the canal owners the percentage of loss in their canals and devising suitable methods by which the flow through each farmer's headgate may be controlled and measured. Measuring devices, including both weirs and rating flumes, have been built under the supervision of the Station officers in different cultivated valleys of the State for the purpose of introducing more modern methods.

## THE USE OF WATER IN IRRIGATION.

For the past two seasons experiments have been carried on by this Station in co-operation with the Office of Experiment Stations at Washington, D. C., to ascertain the actual quantities of water used in irrigation. Without this knowledge it would be impossible to reach any definite conclusions as to the agricultural possibilities of any irrigable tract of land. One might know the amount of the available water supply and the extent of the land to be irrigated, but if he did not know the average amount of water that should be applied per acre, the number of acres that might be reclaimed by the flow of a stream could not be determined.

In like manner, when a storage reservoir is to be built it is important to know, before the enterprise is begun, how much land a given quantity of water will irrigate. It is comparatively easy to obtain the capacity of the reservoir before any construction work is done, but if no tests have been made in the vicinity on the amount of water required per acre the area which the stored water will irrigate can only be roughly estimated.

Then, too, one of the first steps necessary in defining a water right is to ascertain the amount of water economically used. One of the greatest difficulties experienced by the courts in settling water rights is the lack of knowledge on this particular subject. The following table contains a brief summary of the more important investigations on the use of water in irrigation:

Duty of Water in 1899.

Kind of Crop.	Name of County.	Area Irrigated Acres.	Depth of Water.			Water* Applied per Acre. Tons.	No of Irrigations.	Yield per Acre.
			Irrigation.	Rain.	Total.			
Red Clover.	Gallatin	27.44	1.02	.44	1.46	1386.8	2	3.0 tons.
Peas .....	do	4.23	1.10	.41	1.51	1495.6	2	31.25 bu.
Barley .....	do	5.25	1.98	.42	2.40	2692.05	2	45.00 bu.
Wheat.....	do	6.02	1.98	.42	2.40	2692.05	2	57.89 bu.
Barley .....	do	66.39	.98	.41	1.39	1332.4	1	.....
Oats.....	do	23.41	1.53	.38	1.91	2080.2	1	51.00 bu.
do .....	do	7.26	1.34	.36	1.70	1821.9	2	72.75 bu.
do .....	do	2.48	2.16	.36	2.52	2936.8	2	72.75 bu.
do .....	do	25.09	1.28	.44	1.72	1740.3	1	.....

\* Not including Rainfall.

## Duty of Water in 1900.

Kind of Crop.	Name of County.	Area Irrigated Acres.	Depth of Water.			Water Applied per Acre. Tons.†	No. of Irrigations.	Yield per Acre.
			Irrigation Ft.	Rain Ft.	Total Ft.			
Red Clover.	Gallatin	66.39	1.98	.44	2.42	3290.3	2	.....
Barley .....	do	4.14	1.50	.28	1.78	2420.2	2	46.5 bu.
Oats.....	do	25.09	.64	.39	1.03	1400.4	2*	.....
Wheat .....	do	1.00	.77	.30	1.07	1454.8	2	38.33 bu.
Red Clover.	do	1.00	.77	.30	1.07	1454.8	2	1.58 tons.
Oats.....	do	1.00	.56	.39	.95	1291.6	2	75.58 bu.
Peas.....	do	1.00	.56	.39	.95	1291.6	2	1,330 lbs.
Barley .....	do	1.00	1.17	.28	1.45	1971.5	2	87.29 bu.
Oats.....	do	8.51	1.39	.40	1.79	2433.9	2	74.87 bu.
Barley .....	do	4.42	1.96	.42	2.38	3236.0	2	68.59 bu.
Red Clover.	do	7.28	2.70	.44	3.14	4269.2	4	5.02 tons.
Red Clover.	do	35.90	1.79	.44	2.22	3018.3	3	.....
Alfalfa.....	Yellowstone	53.40	1.30	.44	1.74	2365.8	1	5.17 tons.
Orchard ....	Ravalli	40.00	1.46	.13	1.59	2161.9	4	.....
Oats.....	do	161.70	1.30	.13	1.43	1944.3	2	33.37 bu.
Oats.....	do	102.2	6.06	.13	6.19	8416.0	2	34.03 bu.

\* About two-fifths irrigated on second irrigation. † Irrigation water.

## THE AMOUNT OF WATER REQUIRED.

In the spring of 1900, a tract of land on the western edge of the Station farm was set apart for experiments on the proper amount of water to apply in irrigation. Sixteen rectangular plats 50x100 feet were laid off, with an intervening space between every two plats. A flume (Fig. 1) extended along the west edge of the row of plats and conveyed water from the nearest ditch to each plat. The amount of water applied to any one plat was measured by a weir box at the head of the flume.

All plats were seeded to oats May 21, 1900, at the rate of two bushels of seed per acre. On May 30 the percentage, by weight, of soil moisture in the upper two feet of soil over the entire number of plats ranged from 17.29 to 20.95 and averaged 18.95 per cent. The following table gives the results obtained on plats No. 1 to 8, inclusive. Plat No. 1 was not irrigated, but it received some moisture from an adjacent ditch.

No. of Plat.	Depth of Irrigation in Inches.	Yield per Acre.		Yield per Acre of Grain and Straw Tons.	Water Used per Acre. Tons.	No. Tons Water Applied for Each Ton Produce.
		Grain Bushels.	Straw Pounds.			
1.....	0	46.1	1855	1.61		
2.....	2	61.7	2345	2.29	227	99
3.....	8	68.2	2823	2.57	906	353
4.....	9	73.5	2988	2.74	1020	372
5.....	12	74.8	3075	2.81	1360	484
6.....	16	78.2	3398	3.03	1813	599
7.....	20	77.6	3284	2.96	2266	765
8.....	24	83.5	3215	3.03	2719	898

### DISCHARGE OF THE PRINCIPAL RIVERS OF MONTANA.

For several years the irrigation department of the Station has supervised and conducted the hydrographic work of the U. S. Geological Survey in Montana. Gaging stations are established and maintained at favorable locations on the principal rivers of the State and measurements made of the flow at each station from four to twelve times during each year. An observer residing near the gaging station observes and records the height of water at least once a day. These records are mailed to the Experiment Station and are forwarded from thence to Washington, D. C. The data obtained from a number of stream measurements, together with the daily records of the observer, enable the engineer to compute with reasonable accuracy the daily flow, or discharge, throughout the year. The records for the year 1900 have been thus computed and are herein given for the following rivers: Yellowstone, Gallatin, West Gallatin, Middle creek, Madison, Jefferson, Missoula, Big Blackfoot, Bitter Root and Milk river. It should be observed that when ice forms on the surface of a stream neither the gage heights nor the flow can be accurately determined. In the accompanying tables the discharges are given in cubic feet per second. Since 40 Montana miners' inches are equivalent to one cubic foot per second the flow may be converted into miners' inches by multiplying the figures given by the number 40.

## Daily Discharge of West Gallatin River, in Second-feet, for 1900.

Dy.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	700	560	500	630	1200	4165	1300	560	440	560	500	330
2	700	560	500	700	1300	3610	1300	560	440	560	500	330
3	700	560	500	700	1460	4570	1105	560	440	500	500	358
4	700	560	500	700	1745	4900	935	580	560	560	500	385
5	700	630	500	775	1995	4985	935	580	560	560	500	440
6	700	630	500	850	2610	5410	935	500	560	560	500	440
7	700	630	500	1020	2327	4827	935	500	560	560	500	440
8	630	630	500	850	2465	4325	935	500	530	500	500	385
9	630	630	500	775	2610	4405	935	500	440	500	500	385
10	630	630	500	775	3223	4165	850	500	440	500	500	385
11	630	630	500	775	4005	4652	850	500	440	500	440	385
12	630	440	500	775	4005	3145	850	500	385	500	385	385
13	630	440	500	775	3223	3223	775	500	440	500	440	385
14	630	440	500	775	2835	3223	775	500	440	500	440	385
15	560	440	500	775	2760	3533	775	500	500	500	440	385
16	560	440	500	850	2610	3145	700	500	440	500	440	358
17	560	440	500	775	2610	2835	700	518	440	500	440	330
18	560	440	500	850	2685	2610	700	.....	500	500	385	330
19	560	440	500	935	2395	2685	700	500	500	500	330	330
20	560	440	500	1062	2535	2760	700	500	500	500	280	330
21	560	560	500	1200	2610	2835	630	500	500	385	280	330
22	560	560	500	1352	2990	2685	700	500	440	440	330	330
23	560	560	500	1572	3067	2685	630	500	560	500	330	330
24	560	560	500	1250	3377	2685	630	518	500	500	330	358
25	560	560	500	1105	3533	1995	630	518	500	500	330	358
26	560	560	500	1200	4325	1995	630	560	500	500	330	330
27	560	560	500	1200	5155	1630	665	530	500	440	330	330
28	560	500	500	1300	5410	1405	630	530	560	385	330	330
29	560	.....	630	1300	4652	1405	560	530	500	385	330	330
30	560	.....	630	1200	4652	1300	616	500	518	440	330	330
31	560	.....	630	.....	4005	.....	630	440	.....	440	.....	320

**Daily Discharge of Madison River, Near Red Bluff, in Second Feet, for 1900.**  
**(Including Cherry Creek)**

Dy.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	(a)	860	3005	4840	2075	1640	1640	1850	1850	1640
2	.....	(a)	.....	860	3645	4305	2075	1640	1640	1850	1850	1640
3	.....	.....	.....	860	4040	5110	1963	1640	1640	1850	1850	1640
4	(a)	.....	.....	1430	4040	5110	1850	1640	1640	1850	1640	1640
5	.....	.....	.....	1430	4173	5326	1850	1640	1640	1850	1640	1640
6	.....	.....	.....	1430	3775	5380	1850	1640	1640	1850	1640	1640
7	.....	.....	.....	1640	3908	5380	1850	1640	1640	1850	1640	1640
8	.....	(a)	860	1430	4040	5110	1850	1640	1640	1850	1640	1640
9	.....	.....	.....	1430	4173	5110	1850	1745	1640	1850	1640	1640
10	.....	.....	.....	1430	4305	5110	1850	1850	1640	1850	1640	1640
11	(a)	.....	.....	1430	4824	4840	1850	1850	1850	1850	1640	1640
12	.....	.....	.....	1430	4840	4705	1850	1850	1850	1850	1640	1640
13	.....	.....	.....	1430	5110	4040	1850	1745	1640	1850	1640	1640
14	.....	.....	.....	1430	4840	3775	1850	1640	1640	1850	1640	1640
15	.....	(a)	860	1535	4438	3515	1850	1640	1640	1850	1640	1640
16	.....	.....	.....	1640	4173	3260	1850	1640	1640	1850	1640	1640
17	.....	.....	.....	1745	3775	4305	1850	1640	1640	1850	1640	1640
18	(a)	.....	.....	1850	3645	2648	1850	1640	1640	1850	1640	1640
19	.....	.....	.....	1850	3260	2530	1850	1640	1640	1850	1640	1640
20	.....	.....	.....	1850	3515	2300	1850	1640	1640	1850	1640	1640
21	.....	.....	.....	1850	3593	2300	1850	1640	1640	1850	1640	1640
22	.....	(a)	860	2075	3515	2300	1850	1640	1640	1850	1640	1640
23	.....	.....	.....	2300	3645	2188	1850	1640	1640	1850	1640	1640
24	.....	.....	.....	2530	3960	2075	1850	1640	1640	1850	1640	1640
25	(a)	.....	.....	2530	4173	2075	1850	1640	1640	1850	1640	1640
26	.....	.....	.....	2530	4570	2075	1850	1640	1850	1850	1640	1640
27	.....	.....	.....	2530	5110	2075	1850	1640	1850	1850	1640	1640
28	.....	.....	.....	2530	5380	2075	1850	1640	1850	1850	1640	1640
29	.....	.....	860	2530	5655	2075	1850	1640	1850	1850	1640	1640
30	.....	.....	.....	2577	5655	2075	1640	1640	1850	1850	1640	.....
31	.....	.....	.....	.....	5518	.....	1640	1640	.....	1850	.....	.....

(a) Ice.

## Daily Discharge of Jefferson River, at Sappington, in Second Feet, for 1900.

Dy.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	(a)	2020	3870	5890	1870	600	515	1090	1590	1590
2	.....	.....	(a)	2170	3870	5705	1725	600	515	1205	1590	1590
3	.....	.....	(a)	2565	4050	5520	1590	600	515	1265	1590	1590
4	.....	.....	(a)	2810	4140	5705	1590	515	515	1364	1590	1590
5	.....	.....	(a)	2980	4410	5890	1455	515	600	1455	1590	1725
6	.....	.....	(a)	3150	4688	4050	1455	515	600	1495	1455	1725
7	.....	.....	(a)	3330	5058	5705	1455	515	600	1455	1455	1725
8	.....	.....	(a)	3330	5248	5705	1455	515	600	1455	1455	1725
9	.....	.....	(a)	3330	5613	5335	1325	515	600	1455	1455	1725
10	.....	.....	2325	3065	5985	5150	1325	515	685	1455	1455	1725
11	.....	.....	2020	2810	6365	4965	1205	515	685	1455	1455	1725
12	.....	.....	2020	2645	6850	4410	1205	515	685	1455	1455	1590
13	.....	.....	2020	2645	8050	4050	1205	515	685	1325	1455	1590
14	.....	.....	1870	2645	8665	4050	1090	515	685	1325	1455	1590
15	.....	.....	1870	2645	8973	3870	980	515	685	1325	1455	1590
16	.....	.....	1870	2810	9075	3690	875	515	685	1325	1455	1590
17	.....	.....	1725	2810	8773	3870	775	515	685	1325	1455	1455
18	.....	.....	1870	2810	8358	4050	775	515	775	1325	1455	1455
19	.....	.....	2020	2810	8050	4230	685	515	825	1205	1455	1455
20	.....	.....	2020	2980	7740	4410	685	515	875	1205	1455	1455
21	.....	.....	2170	2980	7445	3870	685	515	875	1205	1455	1455
22	.....	.....	2170	3150	7350	3420	685	515	875	1205	1455	1455
23	.....	.....	2325	3330	6948	2810	685	515	875	1325	1455	1455
24	.....	.....	2485	3420	6850	2645	685	515	875	1325	1455	1455
25	.....	.....	2485	3600	6655	2485	685	515	875	1325	1455	1455
26	.....	.....	2485	3690	6558	2325	600	515	980	1455	1455	1455
27	.....	.....	2405	3870	6460	2170	600	475	980	1455	1455	1455
28	.....	.....	2248	3870	6460	2095	600	475	980	1455	1455	1325
29	.....	.....	2020	3870	6655	2020	600	475	980	1455	1590	1325
30	.....	.....	1870	3870	6460	2020	600	515	980	1455	1590	1325
31	.....	.....	1870	.....	6175	.....	600	515	.....	1590	.....	1325

(a) Ice.

## Daily Discharge of Gallatin River, at Logan, in Second-Feet, for 1900.

Dy.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1				940	1575	3870	605	290	400	530	605	680
2				940	1575	3870	530	290	400	530	605	680
3	765			940	1638	4240	530	290	460	530	605	680
4				940	1950	4240	460	290	460	605	605	680
5				940	1950	4333	460	290	460	643	605	680
6				940	2210	4615	460	290	460	680	605	680
7		1030	1345	940	2665	4520	460	290	460	680	605	680
8				940	2505	4055	460	345	460	680	605	680
9				940	2665	3685	400	345	460	605	605	680
10	850			940	3078	3415	345	345	460	605	605	605
11				940	3595	2585	345	345	460	605	605	605
12				940	4055	2210	290	345	460	605	605	605
13				940	4240	2210	240	345	460	605	605	605
14		(a)	940	940	3415	2013	240	345	460	605	605	605
15				1030	3243	1763	240	345	460	605	605	605
16				1030	2995	1575	240	345	460	605	605	605
17	850			1030	2995	1575	240	345	460	605	605	605
18				1130	2995	1460	240	345	460	605	723	605
19				1130	2995	1235	240	345	530	605	895	605
20				1130	2995	1235	210	345	530	605	1030	605
21		(a)	1030	1130	2995	1080	240	345	530	605	1080	605
22				1130	2995	1030	240	345	530	605	1030	605
23				1345	2995	1030	240	345	530	605	940	605
24	1030			1460	3078	1030	240	345	530	605	850	605
25				1575	3505	940	240	345	530	605	765	605
26				1638	3685	940	240	400	530	605	680	605
27				1575	4333	850	290	400	530	605	680	605
28		1030	850	1575	4805	765	290	400	530	605	680	605
29				1575	4805	680	290	400	530	605	680	605
30				1575	4055	605	290	400	530	605	680	(a)
31	1030			4240			290	400		605		(a)

(a) Ice.

**Daily Discharge of Yellowstone River, above Livingston, in Second-Feet,  
for 1900.**

Dy.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	(a)	.....	1265	2490	10660	7270	3395	2100	1715	1500	1305
2	.....	(a)	.....	1340	2855	11540	6945	3270	2100	1793	1500	1355
3	.....	(a)	.....	1420	3000	12485	6600	3240	2050	1760	1500	1340
4	.....	(a)	.....	1500	4075	12975	6470	3130	2050	1733	1500	1340
5	.....	(a)	.....	1500	4730	13725	6220	3060	2050	1715	1500	1340
6	1380	(a)	(a)	1500	5980	15080	5980	3060	2050	1715	1500	1340
7	.....	(a)	(a)	1670	5740	15363	5812	2990	2000	1715	1475	1340
8	.....	(a)	(a)	1950	5623	13375	5775	2990	2000	1688	1460	1340
9	.....	(a)	(a)	1850	6920	14530	5505	2923	1950	1670	1460	1340
10	.....	(a)	(a)	1585	8970	11315	5315	2855	1950	1645	1420	1340
11	.....	(a)	(a)	1585	10375	10875	5165	2790	1900	1628	1355	1340
12	.....	(a)	(a)	1585	11540	10455	5005	2725	1900	1585	1340	1340
13	1420	(a)	(a)	1585	9140	10250	4830	2725	1900	1585	1395	1190
14	.....	(a)	1340	1628	7215	11773	4690	2665	1900	1585	1420	1265
15	.....	(a)	.....	1628	5980	12730	4630	2665	1850	1545	1380	1265
16	.....	(a)	.....	1585	5930	12485	4495	2605	1823	1585	1460	1265
17	.....	(a)	.....	1585	6420	12150	4345	2548	1805	1585	1395	1265
18	.....	(a)	.....	1585	6220	11090	4305	2490	1805	1585	1305	1265
19	.....	(a)	.....	1670	5670	10660	4250	2490	1850	1585	(a)	1265
20	1340	(a)	.....	1950	5860	11090	4160	2433	1850	1545	(a)	1265
21	.....	1340	1265	2150	6170	11060	4075	2433	1805	1545	(a)	1265
22	.....	.....	.....	2375	6600	11315	4040	2433	1805	1545	(a)	1265
23	.....	.....	.....	2923	7070	11005	3900	2375	1760	1585	(a)	.....
24	.....	.....	.....	2605	7550	10373	3815	2375	1760	1585	1190	1190
25	.....	.....	.....	2605	7933	10170	3730	2375	1760	1545	1205	1190
26	.....	.....	.....	2490	9955	9860	3730	2375	1733	1545	1340	1155
27	.....	1340	.....	2375	12485	9245	3730	2318	1715	1545	1380	1155
28	.....	.....	.....	2490	14805	8570	3655	2318	1715	1545	1340	1030
29	.....	.....	.....	2605	13375	8150	3575	2260	1715	1545	1265	1030
30	.....	.....	.....	2663	11450	7935	3500	2205	1715	1500	1265	.....
31	.....	.....	1265	.....	10660	.....	3420	2150	.....	1500	.....	(a)

(a) Ice.

## Daily Discharge of Milk River, at Havre, in Second-Feet, for 1900.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
				355	355	76	21	30	76	129	(a)
				438	315	76	12	12	76	129	(a)
				396	280	63	12	12	91	129	(a)
				315	216	63	12	12	109	109	(a)
				280	216	63	12	39	149	109	(a)
				248	216	63	12	39	355	109	(a)
				216	216	50	12	50	355	109	(a)
				189	189	50	8	76	280	109	(a)
				189	189	63	8	91	248	109	(a)
			485	169	149	76	8	169	216	76	(a)
			485	149	149	91	12	149	189	63	(a)
			840	129	149	50	232	149	189	109	(a)
				587	149	129	50	203	149	169	(a)
				587	149	129	39	149	76	169	(a)
				485	189	129	39	109	76	248	(a)
				438	820	129	39	76	63	280	(a)
				315	1575	129	39	63	63	315	(a)
				396	1205	149	39	39	63	280	(a)
				280	880	109	30	30	63	248	(a)
				280	640	109	30	30	63	216	(a)
				280	587	109	30	21	76	216	(a)
				280	760	109	30	21	109	149	(a)
				280	587	109	21	12	109	149	(a)
				355	485	91	21	12	91	129	(a)
				438	438	91	21	12	76	129	(a)
				438	396	109	21	12	76	129	(a)
				280	355	91	21	12	76	129	(a)
				355	280	91	30	12	63	129	(a)
				280	315	91	21	12	63	129	(a)
				315	280	76	21	12	76	109	(a)
				315	.....	21	30	.....	109	.....	(a)

a) Ice.

**Daily Discharge of Middle Creek, above Flander's Mill, in Second-Feet,  
for 1900.**

Day	June	July	Aug.	Sept.	Oct.	Day	June	July	Aug.	Sept.	Oct.
1....	.....	118	66	48	48	16....	.....	88	51	48	.....
2....	.....	118	66	48	48	17....	.....	88	51	48	.....
3....	.....	88	66	48	48	18....	232	88	51	48	.....
4....	.....	88	66	48	48	19....	192	88	51	50	.....
5....	.....	118	88	48	48	20....	232	88	51	50	.....
6....	.....	88	66	48	48	21....	321	66	51	50	.....
7....	.....	88	66	48	48	22....	232	66	50	48	.....
8....	.....	118	66	48	48	23....	368	66	50	48	.....
9....	.....	118	66	48	48	24....	232	66	50	48	.....
10....	.....	118	57	48	48	25....	232	88	50	48	.....
11....	.....	118	57	48	48	26....	192	66	50	48	.....
12....	.....	88	55	48	48	27....	192	66	50	48	.....
13....	.....	88	53	48	48	28....	192	88	50	48	.....
14....	.....	88	53	48	.....	29....	163	66	50	48	.....
15....	.....	118	51	48	.....	30....	118	66	48	48	.....
						31....	.....	66	48	.....	.....

## Discharge of Bitter Root River, Near Missoula, in Second-Feet, for 1900.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1255	1255	.....	1930	.....	7210	3570	950	1080	1165	1880	1123
1165	1255	.....	2040	.....	7355	3260	950	1080	1080	1930	1123
1123	1255	.....	2540	6400	8100	3110	930	1010	1080	1930	1123
1123	1165	910	3035	7070	9000	2680	910	950	1165	1730	1123
1165	1045	930	3570	8700	9600	2540	890	950	1165	1635	1165
1135	1010	930	3810	9600	10200	2475	870	1010	1123	1635	1165
1165	980	980	3975	10800	10650	2475	870	1045	1165	1445	1255
1165	950	1045	3730	10500	9300	2475	870	1045	1210	1350	1350
1123	950	1080	3490	9750	8700	2280	870	1010	1210	1540	1255
1080	980	1080	3410	10950	7800	2220	870	1010	1165	1350	1255
1080	(a)	1255	3335	12650	6400	2220	870	1010	1165	1255	1165
1123	(a)	1303	3260	14638	6150	1930	853	980	1165	1210	1123
1165	(a)	1350	3335	18150	6150	1830	853	980	1080	1210	1080
1350	(a)	1445	3260	15200	5910	1830	853	950	1045	1165	1080
1540	(a)	1493	3260	11700	5910	1730	853	950	1045	1165	1080
1540	(a)	1683	3410	10200	8700	1635	853	950	1010	1165	1080
1445	(a)	1830	3730	10350	8250	1540	853	1350	1010	1165	1165
1398	(a)	1930	4145	10500	7800	1445	853	1350	1045	1165	1165
1350	(a)	1985	4230	10650	7500	1398	835	1350	1045	(a)	1255
1350	(a)	2040	4320	9600	6795	1398	835	1255	1080	(a)	1255
1255	(a)	2040	4410	8400	7210	1255	800	1255	1165	(a)	1255
1210	(a)	2100	4600	8700	7500	1210	800	1255	1255	(a)	1255
1210	(a)	2100	4410	8400	7650	1165	800	1210	1350	(a)	1255
1210	(a)	2160	4230	8250	7500	1165	835	1255	1445	(a)	1165
1123	(a)	2160	4060	8100	7800	1123	835	1255	1165	1255	1165
1123	(a)	2280	4060	8100	6660	1123	835	1350	1540	1165	1165
1123	(a)	2160	3975	8250	5670	1123	853	1350	1730	1165	1080
1165	(a)	2040	3975	8250	4800	1123	870	1350	1780	1165	1010
1165	.....	2100	.....	8250	4230	1123	870	1255	1780	1165	950
1165	.....	1930	.....	7355	4060	1010	950	1255	1830	1123	950
1255	.....	1930	.....	6795	.....	980	1010	.....	1880	.....	950

(a) Ice,

**Daily Discharge of Big Blackfoot River, Near Bonner, in Second-Feet,  
for 1900.**

Dy.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	824	743	662	1310	3514	3908	1830	1026	986	824	743	(a)
2	824	662	662	1391	3988	4064	1781	1026	905	824	743	(a)
3	905	662	702	1435	3988	4064	1733	986	905	824	783	(a)
4	864	662	581	1733	4160	4064	1643	986	905	824	743	(a)
5	783	702	380	1980	5106	3749	1643	986	905	824	783	(a)
6	702	621	420	2325	5877	3988	1553	986	905	824	824	1067
7	824	662	500	2520	6005	3749	1553	986	905	743	783	986
8	783	581	702	2650	5877	3514	1512	986	905	743	783	824
9	783	540	905	2715	5363	3514	1472	945	824	824	783	743
10	783	621	1512	2585	6005	3357	1472	1026	824	824	824	702
11	783	702	2085	2585	6648	3125	1391	986	905	743	783	783
12	702	702	2980	2520	8061	2980	1391	905	905	743	743	702
13	945	581	3125	2455	12559	2910	1391	905	905	743	783	702
14	905	581	2085	2325	11274	2980	1391	905	905	743	702	702
15	864	540	1781	2455	9989	2080	1310	905	824	743	743	662
16	864	460	1598	2520	8704	3125	1350	1067	824	824	743	662
17	783	621	643	2520	9089	3592	1350	905	824	945	783	581
18	864	540	1350	2520	8961	3514	1269	1067	905	783	662	621
19	864	702	1391	2780	8575	3125	1229	905	824	702	702	621
20	743	662	1148	2990	7676	2910	1269	864	824	702	(a)	662
21	783	662	1107	3200	7290	2980	1229	905	905	662	(a)	864
22	824	702	1107	3278	7162	2845	1188	905	824	743	(a)	905
23	743	702	1188	3592	6391	2715	1107	905	824	702	(a)	783
24	662	662	1269	3749	6391	2650	1026	905	824	783	(a)	824
25	702	662	1229	3671	5877	2520	1026	805	824	702	(a)	783
26	743	581	1188	3671	5234	2325	1148	905	743	743	(a)	824
27	662	621	1269	3671	5106	2200	1229	905	743	824	(a)	783
28	702	621	1310	3435	4977	2085	1067	905	824	783	(a)	702
29	702	.....	1188	3357	4977	2030	1067	864	824	743	(a)	702
30	743	.....	1229	3278	4720	1880	1107	945	824	783	(a)	702
31	743	.....	1310	.....	3988	.....	1107	864	.....	743	.....	581

(a) Ice

## Daily Discharge of Missoula River, at Missoula, in Second-Feet, for 1900.

Dy.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	1534	2480	6540	9400	3260	1404	1278	1430	1560	(a)
2	(a)	(a)	1560	2645	6880	9050	3160	1340	1245	1495	1560	(a)
3	(a)	(a)	1495	3160	7475	9050	2980	1404	1300	1470	1560	(a)
4	(a)	(a)	1365	3560	8175	8875	2760	1340	1278	1664	1625	(a)
5	(a)	(a)	980	4100	9155	.....	2678	1245	1404	1600	1664	1860
6	(a)	(a)	1030	4400	10000	.....	2678	1245	1404	1560	1625	1885
7	(a)	(a)	1365	4900	10600	8175	2645	1190	1495	1664	1625	1820
8	(a)	(a)	1560	4650	10120	8175	2513	1190	1430	1625	1625	1820
9	(a)	(a)	2595	4725	9800	7755	2430	1245	1404	1560	1600	1690
10	(a)	(a)	3600	4475	11120	7580	2315	1135	1365	1560	1625	1600
11	(a)	(a)	5100	4400	12950	6775	2232	1300	1365	1534	1534	1470
12	(a)	(a)	6950	4400	23600	6240	2150	1245	1300	1495	1430	1365
13	1680	(a)	6300	4225	23600	5940	2070	1245	1278	1495	1430	1300
14	1950	(a)	4025	4350	20550	5550	2025	1223	1245	1470	1470	1300
15	1730	(a)	3400	4275	17980	5700	1950	1190	1278	1495	1430	1365
16	1664	(a)	2545	4475	16200	5940	1885	1190	2348	1495	1430	1340
17	1534	450	2760	4475	16850	6775	1860	1080	1600	1470	1600	1365
18	1560	930	2645	4400	16700	7580	1820	1113	1625	1430	(a)	1340
19	1560	(a)	2215	4725	15850	6390	1755	1113	1690	1470	(a)	1300
20	1560	(a)	2348	5100	15450	6000	1625	1080	1664	1470	(a)	1340
21	1600	(a)	2392	5350	13950	5575	1534	1030	1625	1430	(a)	1664
22	1534	1495	2480	5850	13100	5490	1470	1245	1560	1560	(a)	1885
23	1534	1534	2678	6150	12850	5150	1534	1278	1560	1560	(a)	1560
24	1495	1664	2513	6300	12120	5025	1495	1340	1625	1560	(a)	1430
25	1223	1664	2480	6300	11520	4900	1534	1404	1560	1534	.....	1340
26	830	1625	2562	6450	10880	4900	1534	1430	1560	1495	(a)	1300
27	980	1625	2562	6450	10920	4400	1495	1430	1560	1470	(a)	1340
28	730	1625	2562	6300	11000	4025	1495	1340	1534	1495	(a)	1190
29	(a)	.....	2430	6300	10600	3700	1534	1300	1534	1600	(a)	1013
30	(a)	.....	2265	6300	10000	3460	1430	1365	1430	1534	(a)	980
31	(a)	.....	2348	.....	9600	.....	1430	1340	.....	1560	.....	(a)

(a) Ice

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BULLETIN NO. 33.

**MONTANA AGRICULTURAL  
EXPERIMENT STATION**

...OF...

**THE AGRICULTURAL COLLEGE OF MONTANA,**

---

**SUGAR BEETS IN MONTANA,  
THE CROP OF 1901.**

---

**SUGAR BEET SERIES NO. 2.**

---

**BOZEMAN, MONTANA, JANUARY 1902.**

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1902.  
The Avant Courier Publishing Co.,  
Bozeman, Montana.

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**Bozeman, Montana.**

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# Montana Experiment Station.

Bulletin No. 33

January, 1902.

## SUGAR BEETS IN MONTANA.

CROP OF 1901.

F. W. TRAPHAGEN.

The results of sugar beet culture in Montana for the past season have been most gratifying, and we feel renewed confidence in the opinion expressed in Bulletin No. 19, that "Montana conditions are favorable to the production of sugar beets of high sugar content and standard purity."

Great interest has been taken in the sugar beet work this year, because, for the first time, the question of our ability to meet the commercial conditions of this crop, has been taken up seriously by capitalists. Because of this, our work has been supplemented in two important agricultural valleys by others, and, on account of this additional interest, more attention has been given to careful culture. This attention is shown in the results, which, in general, are far better than in any preceding year.

On the Bitter Root Stock Farm in particular, a series of very careful tests were conducted, and the results, in richness, purity and yield, were such as to fully satisfy the most exacting. These tests were conducted by Mr. Thomas Loynd, an experienced sugar beet culturist, from Utah, and were made on different varieties of soil, including the poorer as well as the richer. A perusal of the tables containing the results of these tests will show very striking figures.

Sugar beets in the past have received very scant attention at the hands of those who have planted them in this state. Put in as an accommodation to the Experiment Station, they have been attended to after every other interest has been considered. When irrigated, if at all, they received water not when they most needed it, but when most convenient to the farmer. The same is true of cultivation, and this crop, which responds so readily to painstaking

care, has been left to grow almost unattended. In spite of this, the results have been very pleasing. Montana seems to be the natural habitat of root crops, and the difficulty is to keep down the growth, and prevent the formation of too large roots.

Even at the Experiment Station where the results have been such, that the culture would always have been profitable, both from the standpoint of the producer and of the manufacturer, the sugar beets have been part of a rotation, in which they have been far from being the favored crop.

In the valley of Clark's Fork of the Yellowstone River, the first experimental work was carried on the past year, with an outcome that would indicate this valley as an ideal locality for the establishment of a factory. In the three localities just mentioned, the experiments have been carried on in a sufficiently large scale, to demonstrate the question of profitable sugar beet culture to any who make a careful study of the conditions and results.

The yield, sugar content, and purity, can be kept far above the standards adopted as the minimum values, by sugar beet experts, as demonstrated by the past season's work, which can be improved upon as cultural conditions are bettered. Fuel is easily obtainable and cheap, water is pure and abundant, limestone of great purity is available and land sufficient to produce the crop, and at the same time sustain a logical three year's rotation, is at hand in each of these sections.

No doubt many other sections of the state could show just as good figures, but, unfortunately, the experiments have been lacking in magnitude sufficient to satisfy the intending investor. Many results have been obtained by farmers in different portions of the state, which are entirely satisfactory in themselves, but, which, in order to possess their full value, must be supplemented by experiments by their neighbors.

A factory will not be established anywhere where there is not at least fifteen thousand acres of land within easy reach of the factory, either by rail or country road, which will contribute the beet crop to the factory. This amount of land planted to a three year rotation of clover, grain and beets, would maintain a factory of fair size, but, a smaller area of available land would hardly be considered.

It is the custom of the beet sugar companies to pay for the railroad haul, and where the beets are siloed, to await their call, they pay twenty cents additional per ton. The method of siloing in use is very simple, consisting only in making a trench more or less deep, and as wide as necessity demands, and, after filling with beets, covering over with the loose soil previously removed.

The consumption of sugar in Montana is sufficient to use up all the product of at least one large factory and the protection afforded by the long freight haul, with attendant high tariffs, together with the excellent crop returns, will certainly prove incentives, sooner or later, to the establishment of factories within our borders.

### **Feeding Beets and Pulp.**

Until the product of the sugar beet fields is absorbed by beet sugar factories, and while the experimental work, necessary to prove the claims of various localities, is going on, the roots can be very profitably fed to stock, and prove a very welcome addition to the ordinary dry ration, as well as yielding a distinct gain in flesh, equivalent to a high money return for the beets fed.

The striking results obtained at the Montana Experiment Station in swine feeding experiments, conducted by Prof. Shaw, which are described in Bulletin No. 27, to which readers of this Bulletin are referred, will show the value of beets as food.

This subject has been previously taken up in Bulletin No. 19, and work subsequent to that publication, shows that as a succulent addition to the usual food, the beet is valuable and acceptable. This is particularly true in our own state, where succulent foods are so scarce, especially in winter.

### **Climate.**

The old saying "that the proof of the pudding is in the eating" applies particularly to the discussion of the Montana climate in reference to sugar beet culture. When we can get yields of 25.6 tons per acre, of beets of 19.38 per cent sugar content, and 86.4 per cent purity, as was done in one specially favored portion of the Bitter Root Stock Farm, and when almost every valley in the state produces crops of beets above the general commercial average, who will say the Montana climate is not adapted to sugar beets?

## Experiment Station—Variety Tests.

Lab'y No.....		Av. Wt. Oz.....	Sugar in juice...	Sugar in beet...	Purity Coef.....	Date 1901.....
1805	Miscellaneous .....	20.00	16.8	15.96	84.44	Sept
1831	Kleinwanzlebener, 5770.....	24.8	15.8	15.3	81.00	Sept
1832	Utah Seed.....	25.4	16.5	15.67	85.5	Sept
1833	Zehringen, 3942.....	16.8	15.6	14.82	88.2	Sept
1834	Braune, 2885.....	23.00	16.1	15.19	83.3	Sept
1835	Kleinwanzlebener, Dippe, 3944..	19.6	16.3	15.58	82.02	Sept
1836	Kleinwanzlebener, Russia, 3943..	23.4	15.00	14.25	78.00	Sept
1837	Vilmorin.. .....	20.2	15.8	15.01	79.7	Sept
1838	Unknown Variety.....	20.4	16.6	15.77	85.5	Sept
1842	Kleinwanzlebener, 5770.....	20.5	16.1	15.29	76.3	Oct.
1843	Utah Seed.....	21.00	17.9	17.00	87.5	Oct.
1844	Zehringen, 3942.....	22.00	15.9	15.10	74.6	Oct.
1845	Braune, 2885.....	20.00	17.7	16.71	82.3	Oct.
1846	Kleinwanzlebener, Dippe, 3944..	19.00	19.5	18.52	88.6	Oct.
1847	Kleinwanzlebener, Russia, 3943..	18.00	17.6	16.72	86.1	Oct.
1848	Vilmorin.....	26.5	14.00	13.3	72.9	Oct.
1869	Kleinwanzlebener, 5770.....	25.5	17.0	16.15	86.00	Oct.
1870	Utah .....	17.00	18.5	17.57	84.9	Oct.
1871	Zehringen, 3942.....	15.5	18.3	17.38	83.3	Oct.
1872	Braune, 2885.....	16.5	18.5	17.57	86.3	Oct.
1873	Kleinwanzlebener, Dippe, 3944..	14.00	19.1	18.14	90.5	Oct.
1874	Kleinwanzlebener, Russia, 3943..	14.5	18.6	17.67	88.5	Oct.
1875	Vilmorin .....	17.00	19.2	18.24	87.6	Oct.
1882	Kleinwanzlebener, 5770.....	15.00	18.4	17.48	82.9	Oct.
1883	Utah .....	18.00	19.3	18.33	86.1	Oct.
1884	Zehringen, 3942.....	14.66	20.00	19.00	87.00	Oct.
1885	Braune, 2885.....	16.66	19.9	18.9	87.6	Oct.
1886	Kleinwanzlebener, Dippe, 3944..	18.66	18.3	17.38	85.9	Oct.
1887	Kleinwanzlebener, Russia, 3943..	14.66	18.2	17.29	86.6	Oct.
1888	Vilmorin .....	17.00	17.9	17.00	84.00	Oct.
1966	Kleinwanzlebener, 5770.....	20.8	17.90	17.00	81.8	Oct.
1967	Utah .....	17.4	20.10	19.05	85.00	Oct.
1968	Zehringen, 3942.....	20.00	19.70	18.76	85.5	Oct.
1969	Braune, 2885.....	21.00	19.70	18.74	87.00	Oct.
1970	Kleinwanzlebener, Dippe, 3944..	23.00	19.50	18.46	88.00	Oct.
1971	Kleinwanzlebener, Russia, 3943..	19.00	19.30	18.35	87.5	Oct.
1972	Vilmorin .....	22.00	17.97	17.07	86.00	Oct.

## Averages of all Tests.—Experiment Station.

	Av. weight ounces.....	Sugar in juice...	Sugar in beet..	Purity Coef.....	Tons per acre...	Lbs. sugar per acre.....
wanzlebener, 5770.....	21.32	17.04	16.31	81.6	13.5	4403
.....	19.76	18.44	17.51	85.8	11.7	4007
ingen, 3942.....	17.8	17.91	17.01	83.7	11.45	3895
ne, 2885.....	19.43	18.38	17.42	85.3	10.5	3658
wanzlebener, Dippe, 3944.....	18.85	18.53	17.61	87.00	10.4	3662
wanzlebener, Russia, 3943.....	17.91	17.75	16.85	85.3	9.25	3117
orin .....	20.5	17.13	16.27	84.00	9.5	3091
General Average.....	19.37	17.88	16.98	84.9	10.9	3690

## Averages for Successive Dates.—Experiment Station.

Date 1901.	Av. weight.....	Per cent sugar in juice.....	Per cent sugar in beet.....	Per cent purity.....
ember 28.....	21.7 oz.	15.96	15.20	82.90
per 5.....	21.0 oz.	16.96	16.13	81.19
per 12.....	17.14 oz.	18.46	17.53	86.73
per 19.....	16.38 oz.	18.86	17.92	85.73
per 26.....	20.45 oz.	19.18	18.25	85.83

**Clark's Fork Valley.—Bridger and Gebo.**

The \* indicates that the P. O. address is Gebo; the address of all others is Bridger.

Lab'y No.....	Name.	Av. weight in ounces.....	Sugar in juice...	Sugar in beet...	Purity Coef.....	Tons beets per acre.....	Lbs. sugar per acre.....
1850	P. R. Miller *	8.8	17.1	16.22	79.9	6.5	2108
1854	C. F. Sexton.....	20.00	15.9	15.10	80.3	25.00	7552
1881	A. E. Parker.....	31.5	14.3	13.58	69.4	9.00	2444
1889	William Barclay.....	14.7	16.2	15.39	78.2	12.00	3695
1891	James Barclay.....	19.43	21.3	20.23	82.88	20.00	8092
1903	C. M. Larkin.....	10.8	16.88	16.00	80.00		
1907	W. H. Bostic.....	24.9	19.5	18.52	78.3	20.00	7408
1934	C. H. Bostic.....	9.4	15.5	14.72	67.1		
1935	W. F. Gibson.....	35.5	18.00	17.1	74.4	24.00	8208
1936	Lucy H. Smith.....	28.00	20.1	19.09	83.7	20.00	7636
1937	Hugh Morrow.....	26.5	19.7	18.71	74.5	15.00	5613
1938	R. B. Teesdale.....		18.8	17.86	85.4	25.00	8930
1939	E. T. Bostic.....	28.5	21.9	20.8	88.3		
1940	J. R. Stevens.....	55.00	14.81	14.06	77.4	15.00	4218
1941	S. H. Mendenhall.....	14.8	18.11	17.2	83.8	20.00	6880
1942	Thomas Barnett.....	20.8	16.5	15.67	80.00	12.00	3760
1943	A. G. Duffield.....	32.00	17.8	16.9	83.00	25.00	8450
1944	L. G. Preno.....	24.5	17.9	17.00	79.6	20.00	6800
1945	F. O. Jennings.....	31.00	17.6	16.7	75.00		
1946	B. F. Bayler.....	33.00	22.7	21.56	85.3		
1947	Richard Barrows.....	25.5	18.6	17.67	82.00	20.00	7068
1952	I. A. Goff *	11.6	13.4	12.73	74.44	12.00	3055
1953	F. E. Stevens.....	21.00	16.00	15.20	82.05	25.00	7600
1954	Frank Hiser.....	9.2	19.3	18.33	84.65	15.00	5499
1955	E. D. Lovegreen.....	14.33	16.3	15.48	77.94	15.00	4644
1956	E. T. Preuitt.....	18.66	19.1	18.14	86.80	20.00	7256
1957	W. A. Cowan *	21.00	16.8	15.96	80.00		
1958	E. Cowan.....	15.4	19.8	18.81	90.00	20.00	7524
1959	N. Webber.....	18.6	18.7	17.76	86.12		
1960	C. M. Laughery.....	17.5	19.9	18.90	88.83	20.00	7560
1961	T. E. Stearns.....	18.66	14.7	13.96	76.96		
1950	R. A. Duncan (4).....	25.00	17.7	16.8	80.00		

(4) P. O. Address is Rockvale.

**Bitter Root Stock Farm.—Hamilton, Mont.**

	Average weight ounces.....	Sugar in juice.....	Sugar in beet.....	Purity Coef.....	Tons per acre.....	Lbs. sugar per acre.....
Hamilton Ranch, No. 1.....	17.8	20.1	19.09	87.3	18.9	7216
Hamilton Ranch, No. 2.....	16.6	19.3	18.33	86.9	13.6	4985
Hamilton Ranch, No. 3.....	15.2	20.1	19.9	82.4	22.00	8756
Hamilton Ranch, No. 4.....	8.8	21.1	20.04	87.5	12.7	5090
Gilchrist Ranch, No. 1.....	11.00	20.6	19.57	88.4	18.4	7201
Gilchrist Ranch, No. 2.....	11.6	22.00	20.9	91.2		
Prendergast Ranch, No. 1.....	11.8	19.8	18.81	87.6	20.00	7524
Prendergast Ranch, No. 2.....	13.6	22.1	20.99	92.00	18.00	7556
Lower Ward Ranch, No. 1.....	13.00	21.1	20.04	90.6	18.3	7334
Lower Ward Ranch, No. 2.....	12.4	20.8	19.76	89.2	14.00	5532
Upper Ward Ranch, No. 1.....	13.4	20.3	19.28	87.5	12.00	4627
Corvallis Ranch.....	13.00	20.2	19.19	90.00	14.6	5603
Corvallis Ranch.....	15.6	20.4	19.38	86.4	25.6	9922

**Missoula County.**

Name.	Average weight in ounces..	Sugar in juice.....	Sugar in beet.....	Purity Coef	Tons beets per acre...	Lbs. sugar per acre...
<b>V. H. Daykin, Missoula .</b>						
Kleinwanzlebener .....	17.5	17.3	16.43	77.5		
Vilmorin .....	16.00	17.9	17.00	81.3	16.5	5610
Utah .....	21.5	17.00	16.15	84.9	19.00	6137
<b>Chas. E. Coleman, Missoula.</b>						
Kleinwanzlebener .....	32.66	16.5	15.67	76.03	12.4	3886
Vilmorin .....	19.5	19.7	18.71	86.4	11.5	4303
<b>Henry Buckhouse, Missoula...</b>	10.4	15.5	14.72	85.1	9.00	2650
<b>C. C. Willis, Plains.....</b>						
Kleinwanzlebener .....	10.8	17.4	16.53	87.7	11.00	3636
Vilmorin .....	13.00	18.1	17.19	88.3	12.5	4297
Utah .....	9.00	16.6	15.77	81.7	12.00	3784

## Gallatin Valley.

Lab'y No....	Name.	A. V. weight in ounces..	Sugar in juice.....	Sugar in beet.....	Purity Coef	1000 lbs. Tonn beets per acre...
1879	<b>John A. Moore, Belgrade.....</b>	33.5	12.00	11.40	75.00	
1919	<b>W. A. Caldwell, Belgrade.....</b>	18.6	17.00	16.15	80.5	27.00 8
	<b>A. A. Spaulding, Bozeman....</b>					
1930	Kleinwanzlebener .....	17.66	16.5	15.67	80.5	30.00 94
1931	Vilmorin .....	25.66	15.4	14.63	78.5	36.00 10
	<b>M. M. Ferguson, Bozeman....</b>					
1933	Kleinwanzlebener .....	19.00	16.4	15.58	80.00	

## Cascade County.

Lab'y No....	Name.	A. V. weight in ounces	Sugar in juice.....	Sugar in beet.....	Purity Coef	1000 lbs. Tonn beets per acre...
	<b>Paris Gibson, Great Falls.....</b>					
1839	Utah .....	44.00	13.5	12.82	65.00	
1840	Kleinwanzlebener .....	30.00	11.6	11.00	63.00	
1841	Vilmorin .....	48.00	15.4	14.63	70.00	
1892	<b>C. H. Campbell, Great Falls...</b>	12.00	17.5	16.62	80.00	
1906	<b>John H. C. Dale, Great Falls...</b>	33.00	17.00	16.15	86.28	25.00 8
	<b>Daniel Payne, Monarch.....</b>					
1899	Utah .....	11.8	16.8	15.96	82.00	
1900	Kleinwanzlebener .....	9.66	19.2	18.24	80.3	
1901	Vilmorin .....	7.7	19.2	18.24	78.68	

## Yellowstone County.

Lab'y No....	Name.	A. v. weight in ounces.	Sugar in juice.....	Sugar in beet.....	Purity coef	Tons beets per acre...	Lbs sugar per acre...
1785	Wm. Birely, Billings.....	41.00	4.00	3.8	41.00		
1786	Wm. Birely, Billings ..	38.00	5.4	5.13	56.2		
1902	I. D. O'Donnell, Billings.....	38.00	13.02	12.36	70.00		
1965	I. D. O'Donnell, Billings.....	40.3	12.27	11.65	66.00		
1929	C. D. Hatch, Laurel.....	21.00	18.1	17.2	80.00		

## Park County.

Lab'y No....	Name.	A. v. weight in ounces	Sugar in juice.....	Sugar in beet.....	Purity Coef	Tons beets per acre...	Lbs. sugar per acre...
	<b>L. M. Jones, Myersburg.....</b>						
1920	Kleinwanzlebener .....	17.50	17.4	16.53	77.6	20.00	6612
1921	Vilmorin .....	18.00	16.00	15.20	70.17	21.00	6384
1922	Utah .....	32.00	14.5	13.77	69.04	47. *	12944
1897	Gus Nelson, Livingston.....	23.66	16.9	16.05	78.00	20.5	6498
1948	Andrew Lyall, Livingston....	12.5	17.4	16.53	62.14		
1962	George J. Allen, Livingston...	15.5	18.5	17.57	81.5		

\* Excluded from average.

## Flathead County.

Lab'y No....	Name.	A. v. weight in ounces	Sugar in juice.....	Sugar in beet.....	Purity coef	Tons beets per acre...	Lbs sugar per acre...
1896	Theodore Koenig, Kalispell...	14.00	21.2	20.14	81.7		
1904	Mc. C. Winiger, Kalispell.....	14.00	17.3	16.43	82.38	10.00	3286
1951	C. E. Pettit, Kalispell.....	25.5	19.7	18.64	83.4	19.00	7083
	<b>T. S. Proud, Kalispell.....</b>						
1926	Utah .....	14.2	17.4	16.53	80.55	10.00	3306
1927	Vilmorin .....	21.2	17.7	16.8	78.00	14.00	4704
1928	Kleinwanzlebener .....	9.8	20.2	19.19	87.4	11.00	4222

**Miscellaneous.**

Lab'y No....	Name.	Av. weight in ounces	Sugar in juice.....	Sugar in beet.....	Purity Coef	Tons beets per acre...	Lbs sugar per acre...
1880	W. N. Aylesworth, Deer Lodge	32.00	16.00	15.2	88.00		
1852	James Fullerton, Red Lodge...	29.2	13.9	13.2	66.5	16.00	4224
1890	D. McNeil, Boulder.....	32.00	14.5	13.77	80.1		
1898	John Flaherty, Cold Springs..	14.00	12.6	11.87	85.9		
1853	J. S. Crowder, Lewistown....	17.00	15.4	14.63	71.6	23.00	7552
1923	R. Parkhurst, Victor.....	18.00	14.6	13.97	74.4		
1982	Sidney Ward, Hamilton.....	15.6	21.00	19.95	90.5		
1868	W. M. Wooldridge, Hinsdale..	14.00	15.7	14.91	80.5	20.00	5964
1949	W. M. Wooldridge, Hinsdale..	24.8	14.7	13.96	84.9		
1963	Arthur Millard, Miles City....	16.00	18.4	17.48	78.01		
1851	John Bamber, Glendive.....	18.6	14.00	13.3	76.5		
1849	Geo. W. Dana, Deer Lodge....	11.8	15.3	14.53	75.7		

**General Variety Tests.**

(Exclusive of the Experiment Farm, Bitter Root Stock Farm, and Clark's Fork Valley.)

Variety.	Av. weight in ounces.	Sugar in juice.	Per cent of sugar in beets.	Per cent of purity.
Kleinwanzlebener .....	18.4	17.00	16.15	81.3
Vilmorin .....	21.4	16.85	16.00	79.2
Utah .....	21.5	16.00	15.20	75.99

## LOCALITY AVERAGES.

Locality.	Av. weight in ounces	Sugar in juice.....	Sugar in beet.....	Purity Coef	Tons beets per acre...	Lbs. sugar per acre...
de County (1).....	24.5	16.25	15.4	75.4	25.00	8075
westone County.....	35.66	10.56	10.00	62.6		
ead County.....	16.45	18.9	17.95	82.24	12.8	4520
y County (1).....	19.40	15.2	14.43	82.7	20.00	5968
County (2).....	19.5	16.66	15.94	73.07	20.5	6498
er County (1).....	16.00	18.4	17.5	78.00		
son County (1).....	18.6	14.00	13.3	76.5		
ll County.....	21.9	15.6	14.86	81.8		
us County.....	17.00	15.4	14.63	71.6	23.00	7552
son County.....	23.00	13.50	12.82	83.00		
on County (3).....	29.2	13.9	13.2	66.5	16.00	4244
oula County.....	16.7	17.3	16.46	83.00	13.00	4288
lli County (4).....	16.8	17.8	16.96	82.45		
tin County (5).....	22.88	15.46	14.68	78.9	31.00	9332
r Root Stock Farm.....	13.37	20.60	19.64	87.46	16.5	6771
riment Farm.....	19.37	17.88	16.98	84.9	10.9	3690
's Fork Valley.....	22.7	17.84	16.97	80.5	18.00	6174

- (1). One lot only.  
 (2). One locality only.  
 (3). Excluding Clark's Fork Valley.  
 (4). Excluding Bitter Root Stock Farm.  
 (5). Excluding Experiment Farm.

## COMPARISON OF YIELDS IN MONTANA AND ELSEWHERE.

### Average Montana Results in 1901.

Locality.	Beets	Per cent	Lbs.
	per acre Tons	sugar in the beets	sugar per acre
Bitter Root Stock Farm.....	16.5	19.64	6771
Experiment Farm.....	10.9	16.98	3690
Clark's Fork Valley.....	18.00	16.97	6174
Cascade County (a).....	25.00	15.40	8075
Flathead County.....	12.8	17.95	4520
Valley County (a).....	20.00	14.43	5964
Park County.....	20.5	15.90	6498
Fergus County.....	23.00	14.63	7552
Carbon County (b).....	16.00	13.20	4244
Missoula County.....	13.00	16.46	4288
Gallatin County (c).....	31.00	14.68	9332

- (a). One lot only.
- (b). Excluding Clark's Fork Valley.
- (c). Excluding Experiment Station.

### Germany.

Years.	No. of factories.	Acreage.	Tons beets per acre.	Per cent sugar in beets.	Lbs. sugar per acre.
1890-1891 .....	406	825,825	13.03	12.09	3150
1891-1892 .....	403	861,583	11.41	12.06	2752
1892-1893 .....	401	869,829	11.29	11.94	2696
1893-1894 .....	405	945,995	11.12	12.34	2744
1894-1895 .....	405	1,090,801	13.27	12.15	3225
1895-1896 .....	397	930,749	12.55	13.11	3290
1896-1897 .....	399	1,049,881	13.07	12.66	3,309
1897-1898 .....	402	1,079,810	8.62	12.79	2205
1898-1899 .....	401	1,154,229	11.52	13.15	3029
1899-1900 .....	399	1,154,355	11.79	14.4	3395
1900-1901 .....	395	1,095,790	12.06	14.91	3596

COMPARISON OF YIELDS IN MONTANA AND ELSE-  
WHERE.

## France.

Years.	No. of factories.	Acreage.	Tons beets per acre.	Per cent sugar in beets.	Lbs sugar per acre.
1890-1891 .....	377	547,574	11.3	10.7	2418
1891-1892 .....	370	550,786	10.16	11.6	2357
1892-1893 .....	368	537,690	9.77	10.9	2030
1893-1894 .....	370	543,420	9.27	11.5	2132
1894-1895 .....	367	596,803	12.21	10.15	2478
1895-1896 .....	356	505,851	10.7	12.7	2558
1896-1897 .....	358	608,370	11.37	10.8	2456
1897-1898 .....	344	564,572	11.21	12.9	2892
1898-1899 .....	344	590,347	10.49	13.34	2807
1899-1900 .....	399	626,480	11.81	12.45	2941
1900-1901 .....	342	685,391	10.79	15.01	3239

A careful scrutiny of these tables shows the steady increase in sugar per acre in Germany and France, under constantly improving methods of cultivation. But even with the extreme care in culture and the constant application of fertilizers, the results are far below those obtained in Montana, in every locality in which the experimental work has been carried on. Certainly in some of these localities we have good reason to hope for the location of a beet sugar factory soon.

For an explanation of terms and a general discussion of the problem, the reader is referred to Bulletin No. 19 of this Station, on Sugar Beets in Montana.

An extended Bulletin at this time has been considered unnecessary, for it is believed that the figures given "speak for themselves."



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**BULLETIN No. 34.**

**MONTANA AGRICULTURAL**  
**Experiment Station,**  
**OF THE**  
**Agricultural College of Montana.**

**FARMERS' WEIRS.**  
**ONE METHOD OF MEASURING WATER.**

**PUBLICATION IS THE FIRST OF A SERIES OF FARMERS'**  
**BULLETINS ON IRRIGATION TOPICS.**

**Bozeman, Montana, February 1902.**

**REPUBLICAN,**  
**Bozeman, Montana,**  
**1902.**

# MONTANA AGRICULTURAL EXPERIMENT STATION.

BOZEMAN, - MONTANA.

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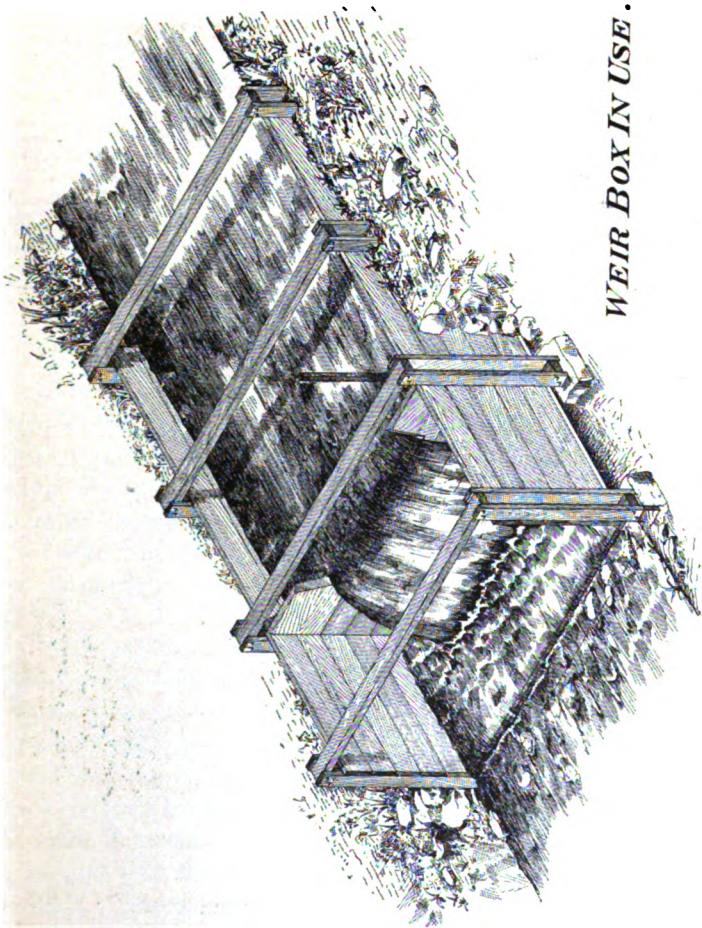
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*WEIR BOX IN USE.*





# Montana Experiment Station.

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BULLETIN NO. 34.

FEBRUARY 1902.

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## FARMERS' WEIRS.

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BY S. FORTIER, DIRECTOR.

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### INTRODUCTION.

During the crop growing season the irrigators of Montana divert large volumes of water from the natural channels of the stream. When the natural supply is limited to the flow of a small creek a few farmers may convey the entire amount through small ditches. When the stream is large a score or more of canals, each supplying water to hundreds of farmers, may be in use. In all cases other than exclusive individual ownership the equitable division of irrigation waters is a necessity.

For a long period after the first settlement of the fertile valleys of the state, water was abundant and little attention was paid to accurate measurements, or a just division. In some favored sections these conditions still prevail. So long as water for irrigation is cheap and plentiful western farmers, as a rule, do not trouble their minds about either irrigation laws or suitable measuring devices. Until March 12, 1885 Montana had no legal standard for measuring water in motion. In that year the legislature enacted the following:

"Sec. 1262. The measurement of water appropriated under this chapter shall be conducted in the following manner: A box or flume shall be constructed with a head gate placed so as to leave an opening of six inches between the bottom of the box or flume and the lower edge of the head gate, with a slide to enter at one side of and of suffi-

cient width to close the opening left by the head gate, by means of which the dimensions of the opening are to be adjusted. The box or flume shall be placed level, and so arranged that the stream in passing through the aperture is not obstructed by back water, or an eddy below the gate; but before entering the opening to be measured the stream shall be brought to an eddy, and shall stand three inches on the head gate and above the opening. The number of square inches contained in the opening shall be the measure of inches of water."

From 1885 to 1898 the miners' inch box just described was the only legal method of measuring irrigation water and the court decrees of that period in relation to all water right suits are expressed in Montana statutory inches.

This box which was designed to measure miners' inches consisted generally of a short flume having a bottom and two sides. At the upper end a board three inches wide was fastened six inches above the top of the floor. The opening formed between the lower edge of the board and the floor was controlled by a slide, or gate, which moved horizontally. When the box was in place the irrigation stream to be measured was turned on and the slide so adjusted that the surface of the water at the upper end of the box was level with the top of the three inch board. It was an easy way of measuring water under a six inch pressure, for the distance from the top of the three inch board to the center of the opening was intended to be six inches. In measuring a stream if the slide were drawn out 15 inches at the time the water was level with the top of the three inch board the opening thus made would be six inches high and 15 inches long and contain 90 square inches. The amount of water flowing through this opening of 90 square inches under an average head of six inches would represent 90 miner's inches.

This method of measuring water has been severely criticised by the engineers of the state. Their objections may be summarized as follows:

- (1) It is not accurate.
- (2) It can only be used to measure small streams.
- (3) It is not adapted to continuous measurements.
- (4) It favors the large consumer.
- (5) The flow may be considerably increased or diminished by slight changes.

6) Miners' inches vary in quantity in different localities of the

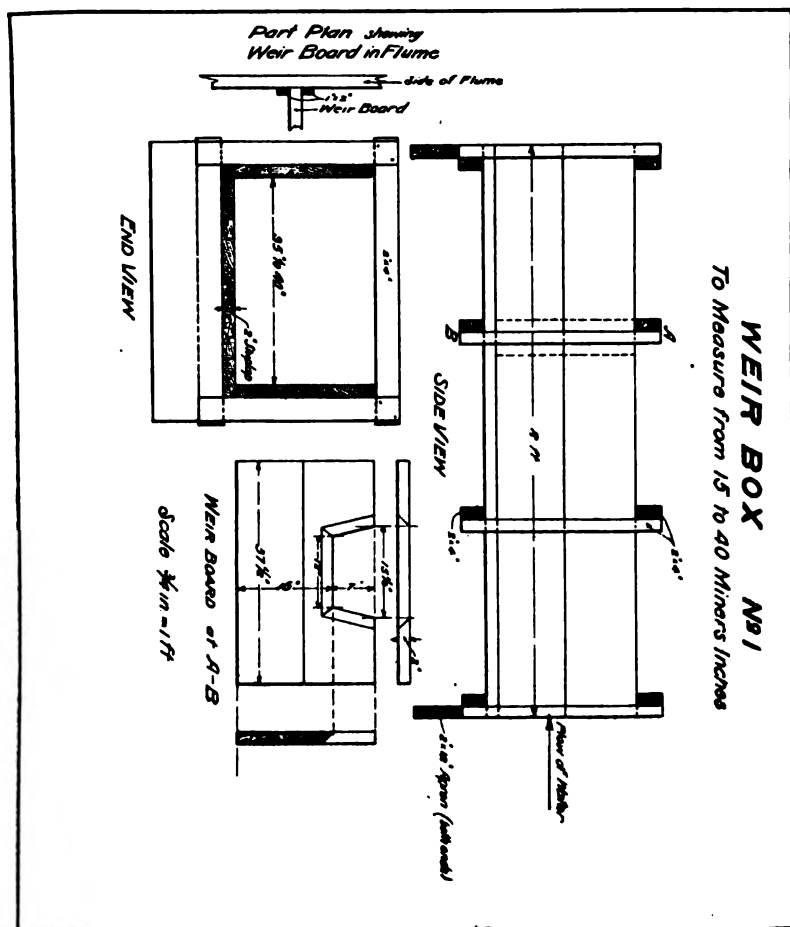
In 1898 the state legislature established a new standard unit, and the Montana miners' inch and repealed all laws in conflict with. This enactment is still in force and the standard units others will be described under the next heading.

### DEFINITIONS.

**CUBIC FOOT PER SECOND.**—The standard unit for flowing water in Montana as well as in most of the western states and territories, is a cubic foot of water, moving at the rate of a lineal foot in one second of time. Each foot in length of a flume one foot wide and one foot high inside measurement and flowing full of water would contain one cubic foot of water. Now if this flume were placed on such a grade that the average rate of flow of water within it would be just one foot of distance for each second of time it would carry a volume equal to the standard unit. This unit is often abbreviated into the two words **SECOND-FOOT**.

In considering this standard for flowing water, irrigators should include that a volume of a certain definite size is necessary. It is apparent to all that a flume six inches wide and six inches high with water flowing at the average rate of 4 feet per second would deliver one cubic foot per second. In general, the flow of any stream may be obtained by multiplying the width and depth of the channel in feet by the average rate of flow in feet. A flume, for example, which is six feet wide inside and carries water to a depth of one foot would contain  $6 \times 1 = 6$  square feet of water area. Now, if it is found that the average rate of flow is two feet per second the total flow is  $2 \times 6$ , or 12 cubic feet per second. In the case of a ditch in which the bottom is curved the area is not so readily found but the principle involved is the same.

**MONTANA MINERS' INCH.**—Like the bushel measure for grain the miners' inch is likely to be continued long after that method of measurement has been abandoned. I do not know of a single Montana farmer that now measures his grain by means of a bushel measure and yet the large majority indicate their yields in bushels.



Bill of Material for Weir Box No. 1.

No. of Pieces.	Actual Dimensions	B. M. Feet	Where Used.	Remarks.
4	In. In. Ft. In. 2 x 12 x 8	64	Lining Sides.	Lumber, Rough.
3	2 x 12 x 8	48	Lining Bottom.	" "
1	2 x 10 x 8	18½	" "	" "
8	2 x 4 x 4 2	22½	Sills and Ties.	" "
8	2 x 4 x 2 10	15	Posts.	" "
2	2 x 12 x 4 2	16¾	Aprons.	" "
2	2 x 12 x 3 1½	12½	Weir Board.	Clear Lumber Surface.
4	1 x 2 x 2	1¼	Cleats, sides.	" " "
2	1 x 2 x 3	1	Cleats, bottom.	" " "

7 lbs. 20d wire nails.

½ lb. 6d wire nails.

per acre. Scales of all kinds have now become so common that the old fashioned measure of our grandfather's time is no longer used. There have been like changes in the devices used to measure water and while we still retain the term miners' inch we seldom ascertain the flow by the miners' inch box. For small streams of water such as are applied to orchard and garden tracts the miners' inch is a convenient unit and there are advantages in continuing its use. In adopting a new standard the members of our state legislature foresaw the extended use of the old unit and so defined it in accurate terms. Forty (40) Montana miners' inches are the exact equivalent of one cubic foot per second. An irrigation stream containing 80 miners' inches would be described as two second-feet by the new standard, one containing 120 miners' inches as three second feet, and so on.

**ACRE-FOOT.**—The second-foot and the miners' inch can only be used for water in motion. It is often convenient in irrigation to describe a certain volume of water in a state of rest. The cubic foot might have been adopted for this purpose had it not been too small. It would have been but a drop in a bucket when compared with the large quantities used in irrigation. Accordingly the acre-foot has been quite generally adopted.

This unit represents the quantity of water which would cover an acre to the depth of one foot. Since there are 43560 square feet in an acre, an acre-foot contains 43560 cubic feet. Rainfall is measured in depth over the surface and of late years the tendency has been to measure water for irrigation in the same way. One frequently hears it stated by practical irrigators that forty acres of spring wheat will require 40 miners' inches. But this statement conveys no definite idea as to the actual amount of water applied to the wheat field because the number of days the stream has been allowed to run on the field is not given. When, however, one states that 60 acre-feet were applied in two irrigations it shows that a certain definite volume of water was used during stated periods and that this volume was sufficient to have covered the 40 acre field to a depth of  $1\frac{1}{2}$  feet.

**ONE IRRIGATION.**—How much water does it require for one irrigation? The amount will, of course, vary with a score or more of conditions. It may interest the reader to know that of 44 experiments

made by this Station in different parts of Montana the average was 10 inches of water over the surface irrigated. This amount included all waste incurred on the field but did not include the losses in conveying the water from the natural channel to the borders of the field. The writer has found that with well made field laterals and skilled irrigators 6 inches of water will suffice to wet the soil to an average depth of one foot.

**THE STANDARD UNIT AND THE ACRE-FOOT.**—Irrigators frequently wish to convert running water into volumes. It may interest them to learn that a second-foot, or 40 miners' inches, flowing on an acre for one hour will cover it to a depth of one inch. If this stream is allowed to flow on an acre for a day it will cover it to a depth of two feet. This rule is not quite exact but may be used in general practice.

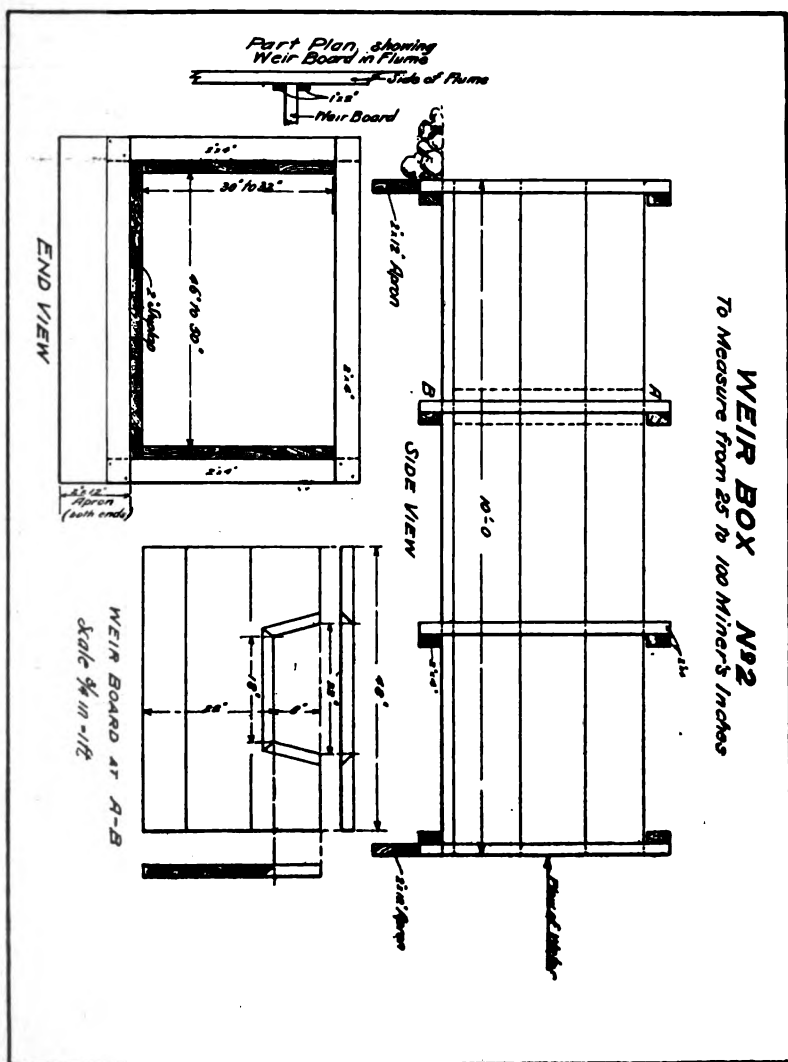
### **Irrigation Water Should be Measured.**

Throughout the irrigated portions of Montana, 40 acres of land with 20 miners' inches of water will produce more than 80 acres without water. If this be true, and the statement would seem to be extremely conservative, a miners' inch of water apart from the cost of irrigation is equal in value to two acres of land. Still one finds that land is measured and mapped and when sold the purchaser is careful to see that the deed is valid and properly recorded. Whereas, in the case of irrigation water probably less than five per cent of the total volume used in the state has ever been measured.

### **The New Standard.**

I am often asked to explain the new way of measuring water. The Montana legislature has prescribed no new method. It has merely adopted a standard unit in which all volumes of running water are hereafter to be expressed.

The same legislative assembly might have adopted the hundred weight as the standard unit for the sale of all grains and defined the bushel as equivalent to 50 pounds. Such a law would not have compelled farmers to use a particular make of scale or prevented them from using the bushel measure. The citizens of the state may measure



## Bill of Material for Weir Box No. 2.

No. of Pieces.	Actual Dimensions.	B. M. Feet.	Where Used.	Remarks.
6	In. In. Ft. In. 2 x 12 x 10	120	Lining, Sides	Lumber, Rough.
4	2 x 12 x 10	80	Lining, Bottom	" "
1	2 x 6 x 10	10	Lining, Bottom	" "
8	2 x 4 x 5	26 $\frac{1}{2}$	Sills and Ties	" "
8	2 x 4 x 8 4	17 $\frac{1}{2}$	Posts	" "
2	2 x 12 x 5	20	Aprons	" "
2	2 x 12 x 4	16	Weir Board	Clear Lumber Surface.
1	2 x 10 x 4	6 $\frac{1}{2}$	Weir Board	" " "
4	1 x 2 x 2 6	1 $\frac{1}{2}$	Cleats, Sides	" " "
2	1 x 2 x 4	1 $\frac{1}{2}$	Cleats, Bottom	" " "

7 $\frac{1}{2}$  lbs. 30d wire nails. $\frac{1}{2}$  lb. 6d wire nails.

irrigation water by any accurate method providing the results are expressed in cubic feet per second.

**CURRENT METER MEASUREMENTS.**—Of late years small instruments called current meters have been manufactured by several firms at prices ranging from \$50 to \$200 each. These meters indicate the velocity of the water in any open channel and the mean velocity when multiplied by the area of the section gives the discharge. This mode of measuring water has become quite popular owing to the ease and rapidity with which it can be done and also to the fact that fairly accurate results can be obtained without the use of flumes, boxes, or other devices.

**RATING FLUMES.**—For occasional measurements the earthen channel of a ditch, or canal, answers all purposes but when more accurate and continuous measurements are desired rating flumes are usually constructed. These consist of wooden flumes as wide as the water channel and from 8 to 24 feet in length placed to conform with the grade of the canal. The velocity of the water is found by a current meter and the depth of water is often recorded on a sheet attached to a self registering machine which needs attention only every seventh day.

**WEIR BOXES.**—A weir box usually consists of a flume with the lower end enclosed. In the middle of the top of the lower end a notch is cut through which the water to be measured flows. Weirs require no instruments other than a foot rule, they are easily and cheaply made and measure flowing water within two per cent of accuracy when all the requisite conditions are fulfilled. Weir boxes as compared with miners' inch boxes are more accurate can be built for the same if not for less money and can be used to measure much larger volumes. The chief defects of this device are that the box often fills with sediment which must be removed and that the water as it issues from the notch requires a drop of at least double the depth of water flowing through the notch.

### Where to Place Farmers' Weirs.

For nearly half a century western irrigators have tried to devise a way by which water might be measured as it flows through a headgate.

It is hoped to make one structure answer two purposes. In this case we have failed for the reason that water is so much agitated and so irregular in flow as it passes through a headgate as to render it impossible to secure an accurate measurement. Of late years, measuring-boxes have been placed at the most suitable points below the headgates and the latter control the stream while the former indicate the flow. This rule applies to weirs. It is well to have a space of at least 50 ft. between the two structures and if a better site can be secured farther down the ditch the intervening distance may be increased several hundred feet.

The weir boxes from No. 1 to No. 4 inclusive sketched in this bulletin are intended to be placed near the head gates of farmers' ditches which divert water from natural streams or canals. These boxes are designed to measure from 5 to 300 miners' inches and are intended for individual, and in the case of the larger sizes, for partnership use. Weir box No. 5 may be used at the head of a large lateral, or on one of the branches of a canal. It will measure sufficient water to supply the needs of from 5 to 15 farmers.

### How to Place Weir Boxes.

Attention has already been called to the fact that weirs require a level bed and with this in mind select for a site a part of the ditch that has a heavy grade.

The weir box should be placed on a level in both directions having a floor at the lower end on a level with the bottom of the ditch. The ditch banks above the weir box should be raised in order that water may flow through the notch in the weir board. When the weir box is in position the apron is inserted in front and moist earth is carefully tamped around the side. The ditch for a distance of 10 feet, or more, above the weir box should be regular and equal in depth and width to the inner dimensions of the box. Care must be taken that no water escapes either beneath or at the sides of the box.

In the case of the smaller sizes, the box may be built at the most convenient place, hauled to the site and then put in place.

It is usually more convenient to build it on the site. The

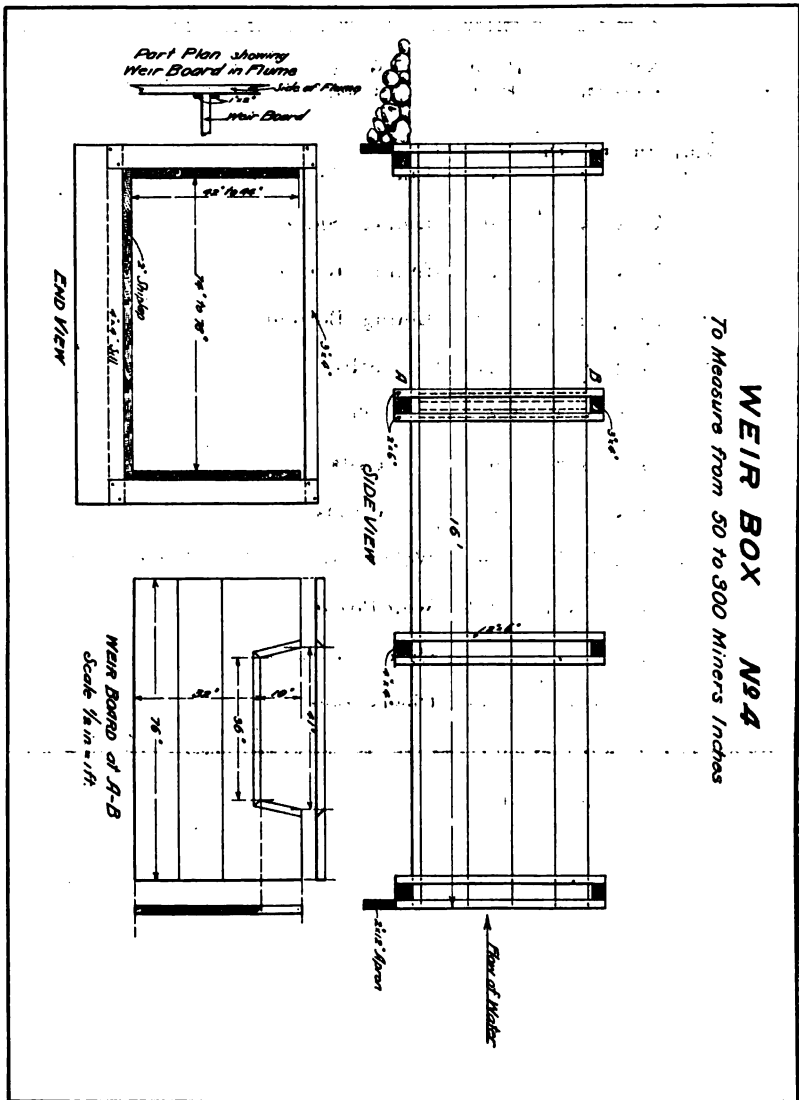


## Bill of Material for Weir Box No. 3.

No. of pieces.	Actual Dimensions.	B. M. Feet,	Where Used.	Remarks.
6	In. In. Ft. In. 2 x 12 x 12	144	Lining, Sides	Lumber, Rough
2	2 x 10 x 12	40	Lining, Sides	" "
3	2 x 12 x 12	72	Lining, Bottom	" "
4	2 x 10 x 12	80	Lining, Bottom	" "
4	4 x 4 x 6 4	34	Sills.	" "
4	3 x 4 x 6 4	24	Ties.	" "
16	2 x 4 x 4 2	67	Posts.	" "
2	2 x 12 x 6 4	25½	Aprons.	" "
1	2 x 18 x 5 4½	16	Weir Board	Clear Lumber surfaced.
2	2 x 12 x 5 4½	21½	Weir Board	" " "
4	1 x 2 x 3 4	2¼	Cleats on Sides	" " "
2	1 x 2 x 5 4½	1½	Cleats, Bottom	" " "

11 lbs. 20d wire nails.

½ lb. 6d wire nails.

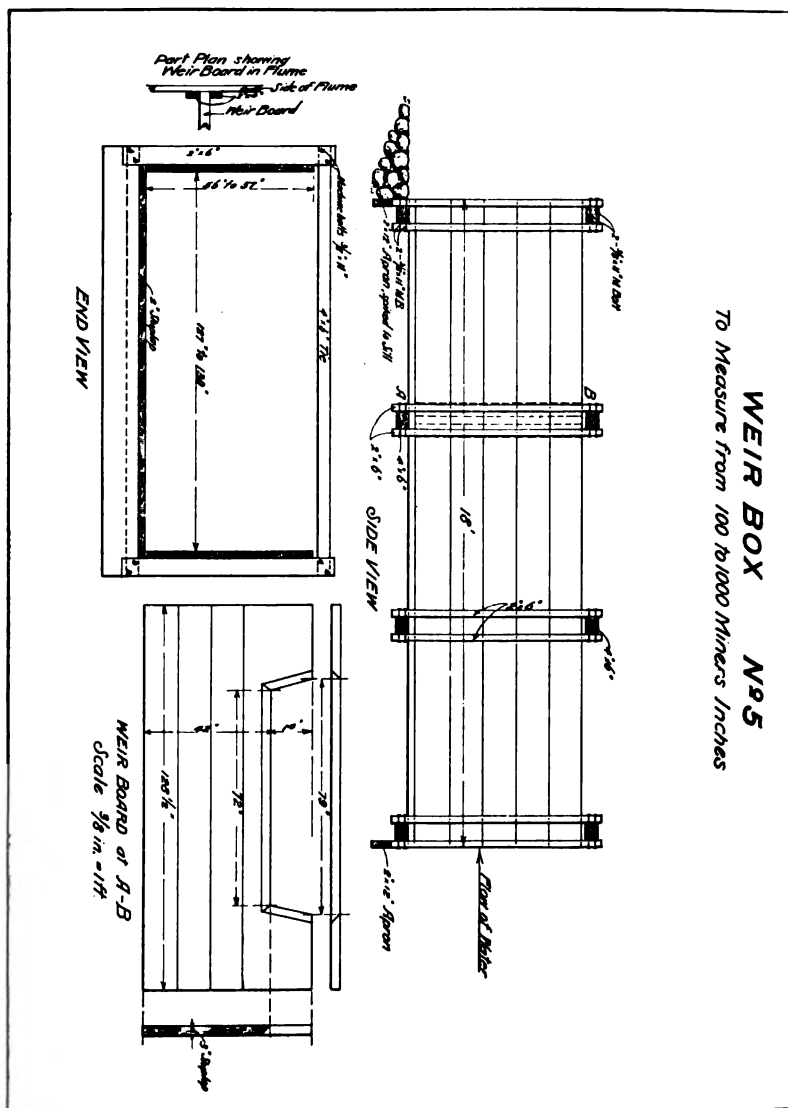


## Bill of Material for Weir Box No. 4.

of ss.	Actual Dimensions.	B. M. Feet,	Where Used.	Remarks.
In. In. Ft. In.				
2 x 12 x 16	190	Lining, Sides	Lumber, Rough	
2 x 10 x 16	53 $\frac{1}{3}$	Lining, Sides	" "	
2 x 12 x 16	128	Lining, Bottom	" "	
2 x 10 x 16	106 $\frac{2}{3}$	Lining, Bottom	" "	
4 x 4 x 7 8	40 8-9	Sills.	" "	
3 x 4 x 7 8	30 $\frac{2}{3}$	Ties.	" "	
2 x 6 x 4 4	69 $\frac{1}{3}$	Posts.	" "	
2 x 12 x 7 8	30 $\frac{2}{3}$	Aprons.	" "	
2 x 16 x 6 4	16 8-9	Weir Board	Clear Lumber surfaced.	
2 x 14 x 6 4	29 5-9	Weir Board	" " "	
1 x 2 x 2 6	1 $\frac{2}{3}$	Cleats on Sides	" " "	
1 x 2 x 6 4	2 1-9	Cleats, Bottom	" " "	

12 lbs. 20d wire nails.

1 lb. 6d wire nails.



## Bill of Material for Weir Box No. 5.

Actual Dimensions.				B. M. Feet	Where Used.	Remarks.
In.	In.	Ft.	In.			
2	x	12	x	18	360	Lining Sides. Lumber, Rough.
2	x	12	x	18	432	Lining Bottom. " "
4	x	6	x	12 ½	193	Sills and Ties. " "
2	x	6	x	5 8	91	Posts. " "
2	x	12	x	12 ½	48	Aprons. " "
3	x	20	x	10 8 ½	53 ⅓	Weir Board. Clear Lumber Surfaced.
3	x	14	x	10 8 ½	112	" " " " "
2	x	4	x	2 6	6 ⅔	Cleats, sides. " " "
2	x	4	x	11	14 ⅔	Cleats, bottom. " " "

10 lbs. 20d wire nails.

1 lb. 6d wire nails.

32 ⅜ in. x 11 ins. Machine bolts.

frame work or yokes are first framed and put into position after which the flooring and sides are nailed on and last of all the weir board is inserted.

### Weir Gauges.

When great accuracy is required the depth of water over the crest of the weir is found by means of an instrument called a Hooke Gauge. The farmer uses simpler if less accurate methods. When the weir box is placed, care should be taken to have the bottom of the notch, or crest, level. An ordinary carpenter's spirit level may be used for this purpose. When the crest is horizontal, one end of the spirit level is placed on the center of the crest and when level the other end will mark the point for the zero of the weir gauge. In rough work a nail may be driven part way into the side of the box, the top of the nail being level with the crest of the weir. A thin plate of brass is to be preferred to a nail. In other cases gauges are inserted on the sides of the flume and properly marked in tenths of feet or inches. At other times a post from 1 to 2 inches square is placed in the center of the box and several feet above the weir board. The top of this post is on a level with the crest.

### Drawings of Weir Boxes.

The first sketch represents a weir box in use and is introduced for the purpose of conveying some idea of the manner of placing such boxes in a lateral, or ditch. The gauge post referred to in a former paragraph is shown beneath the second tie-beam. Measurements are made from the top of the post.

WEIR BOX No. 1—is designed to measure from a few miners' inches up to 40 miners' inches. The length of the weir notch is 12 inches.

WEIR BOX No. 2—will measure volumes from 25 to 100 miners' inches. If extreme accuracy is not required it will also measure from 1 to 25 miners' inches. The preceding statement applies to all the sketches introduced in this bulletin.

WEIR BOX No. 3—should be used for all streams that do not exceed 200 miners' inches.

WEIR BOX No. 4—has a length of weir of 3 feet and will measure

quantities of water ranging from a few miners' inches to 300 miners' inches.

WEIR BOX No. 5—represents the kind of box to insert on main laterals which supply a number of individual shareholders. If it be desired to measure volumes larger than 1000 miners' inches the length of the weir may be increased from 7 to 8, 9 or 10 feet. Any increase in the length of the weir should be followed by a like increase in the other parts of the box. On the other hand if the volume to be measured be less than 1000 miners' inches the length of the weir in No. 5 may be decreased to 5 or 4, feet decreasing the other parts in proportion.

### Weir Tables.

TABLE No 1—was prepared by Mr. J. S. Baker, Instructor in Civil Engineering, assisted by Mr. W. B. Freeman. To accommodate the farmers who use for the most part a carpenter's rule or a square, the depths over the crest are given in inches and fractions of an inch. The discharges are given in Montana miners' inches and were computed to the nearest whole number from the formula.  $Q = 3.3\frac{1}{2} L H^{\frac{3}{2}}$

TABLE No. 2—is inserted for the benefit of engineers and canal superintendents who use decimal parts of a foot instead of inches and fractions thereof. The discharges are expressed in cubic feet per second. This table is taken from Bulletin No. 86 of the Irrigation Investigation series of the Department of Agriculture and was computed by Mr. C. T. Johnston under the supervision of Professor Elwood Mead.

### How to Measure Water Over Weirs.

The method to follow can best be shown by examples. Let us suppose that a farmer has made and placed a box similar to the one shown in drawing No. 1. After turning in the water and allowing it some time to attain a uniform flow he proceeds to the weir box and with an ordinary rule measures the depth of water flowing through the weir notch. Bear in mind that this measurement is not made at the weir board but at the regular gauge whether it be a nail, brass plate, or post as described under that head. We will assume that the depth

as found by the rule is  $3\frac{1}{2}$  inches. Now by referring to Table 1 he follows down the first column until  $3\frac{1}{2}$  is reached. The weir used is one foot and under the column marked '1-foot weir' and opposite the figure  $3\frac{1}{2}$  already found he finds the number 21 which indicates the number of miner's inches flowing over a one foot weir when the depth of water is  $3\frac{1}{2}$  inches. If the depth had been 4 inches, the flow would have been 26 miners' inches; if 6 inches, 48 miners' inches and so on.

As a second example, let us suppose that Weir box No. 3 is put in place and the water turned on. The depth as measured is, say 4 inches. Now we search for figure 4 in the first column and then find the discharge in the column marked '2-foot weir' which is 52 miners' inches. If the depth had been 8 inches the discharge would have been 147 miners' inches thus showing that the discharge over weirs is not in proportion to the depth.

### Acknowledgment.

It is fitting that we should express our indebtedness to Cesare Cippoletti, the celebrated Italian Engineer who has given to the world the Cippoletti Weir and to Director L. G. Carpenter of Colorado for introducing this weir into Western America. In the foregoing pages the writer has attempted to describe how Cippoletti weirs may be made and used by Western farmers.

I have also to acknowledge the assistance rendered by Professor Elwood Mead of the office of Experiment Stations, Washington, D. C.

Mr. K. C. Schaub, a former student of the writer, prepared the drawings.

TABLE I. Discharges of Farmers' Weirs of Different lengths, expressed in Montana Miners' Inches.

Depth of water on crest.	1 foot weir.	1½-ft. weir.	2-foot weir.	3-foot weir.	4-foot weir.	5-foot weir.	6 foot weir.	7-foot weir.	8-foot weir.	9-foot weir.	10-ft. weir.
Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.	Miner's Inches.
½	½	¾	5-16	7-16	9-16	11-16	¾	1	1¼	1½	1 7-16
¾	¾	1½	¾	1 3-16	1 9-16	2	2 5-16	2¾	3¼	3½	4
3-8	¾	1½	1½	2¼	3	3¾	4½	5¼	6	6¾	7½
1-2	1½	1¾	2¼	3½	4½	5¾	6¾	8	9½	10¾	11½
5-8	1½	2	3	5	6	8	10	11	13	14	16
¾	2	3	4	6	8	11	13	15	17	19	21
7-8	3	4	5	8	11	13	16	19	21	24	27
1	3	5	6	10	13	16	19	23	26	29	32
1½	4	6	8	12	15	19	23	27	31	35	39
1¼	5	7	9	14	18	23	27	32	36	41	45
1¾	5	8	10	16	21	26	31	37	42	47	52
1½	6	9	12	18	24	30	36	42	48	54	60
15-8	7	10	13	20	27	34	40	47	54	60	67
1¾	7	11	15	22	30	38	45	52	60	67	75
1¾	8	12	17	25	33	42	50	58	67	75	83
2	9	14	18	27	37	46	55	64	73	83	92
2½	10	15	20	30	40	50	60	70	80	90	100
2¼	11	16	22	33	44	55	66	77	87	98	109
2¾	12	18	24	36	47	59	71	83	95	107	119
2½	13	19	26	38	51	64	77	90	102	115	128
25-8	14	21	28	41	55	69	83	97	110	124	138
2¾	15	22	30	44	59	74	89	103	118	133	148
2¾	16	24	32	47	63	79	95	111	126	142	158
3	17	25	34	51	68	85	102	119	136	152	169
3½	18	26	36	54	72	90	108	125	143	161	179
3¼	19	28	38	57	76	95	114	133	152	171	190
3¾	20	30	40	60	80	100	121	141	161	181	201
3½	21	32	42	64	85	106	127	149	169	191	212
35-8	22	34	45	67	89	112	134	157	179	201	224

TABLE 1. Discharges of Farmers' Weirs of Different lengths, expressed in Montana Miners' Inches.—CONTINUED.

Depth of water on crest.	1-foot weir.	1½-foot weir.	2-foot weir.	3-foot weir.	4-foot weir.	5-foot weir.	6-foot weir.	7-foot weir.	8-foot weir.	9-foot weir.	10-foot weir.
Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.
3¾	24	35	47	71	94	118	141	165	188	212	235
3⅞	25	37	49	74	99	124	148	173	198	222	247
4	26	39	52	78	104	130	155	181	207	233	259
4⅛	27	41	54	81	109	136	163	190	217	244	271
4¼	28	43	57	85	114	142	170	199	227	255	284
4⅝	30	44	59	89	119	148	178	207	237	267	296
4½	31	46	62	93	124	155	185	216	247	278	309
4⅞	32	48	64	97	129	161	193	226	258	290	322
4¾	34	50	67	101	134	167	201	235	268	302	335
4⅞	35	52	70	105	139	174	209	244	279	314	349
5	36	54	72	109	145	181	217	254	290	326	362
5⅛	38	56	75	113	150	188	225	263	301	338	376
5¼	39	58	78	117	156	195	234	273	312	350	390
5⅝	40	61	81	121	161	202	242	282	323	362	404
5½	42	63	84	125	167	209	251	292	334	376	418
5⅞	43	65	86	130	173	216	259	303	346	389	432
5¾	45	67	89	134	179	223	268	313	357	402	447
5⅞	46	69	92	138	185	231	277	323	369	415	461
6	48	71	95	143	190	238	286	333	381	429	476
6⅛	49	74	98	147	196	246	295	344	393	442	491
6¼	51	76	101	152	202	253	304	354	405	455	506
6⅝	52	78	104	156	209	261	313	365	417	469	521
6½	54	81	107	161	215	269	322	375	429	483	537
6⅞	55	83	110	166	221	276	331	387	442	497	552
6¾	57	85	114	170	227	284	341	398	454	511	568
6⅞	58	88	117	175	234	292	350	409	467	525	584
7	60	90	120	180	240	300	360	420	480	540	600
7⅛	62	92	123	185	246	308	370	431	493	554	616
7¼	63	95	126	190	253	316	379	443	506	569	632

TABLE 1. Discharges of Farmers' Weirs of Different lengths, expressed in Montana Miners' Inches.—CONTINUED.

Depth of water on crest.	1-foot weir.	1-½-foot weir.	2-foot weir.	3-foot weir.	4-foot weir.	5-foot weir.	6-foot weir.	7-foot weir.	8-foot weir.	9-foot weir.	10-foot weir.
Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.
7 <sup>3</sup> / <sub>8</sub>	65	97	130	195	260	324	389	454	519	584	649
7 <sup>1</sup> / <sub>2</sub>	67	100	133	200	266	333	399	466	532	599	665
7 <sup>5</sup> / <sub>8</sub>	68	102	136	205	273	341	409	477	546	614	682
7 <sup>3</sup> / <sub>4</sub>	70	105	140	210	280	349	419	489	559	629	699
7 <sup>7</sup> / <sub>8</sub>	72	107	143	215	286	358	430	501	573	644	716
8	73	110	147	220	293	367	440	513	586	660	733
8 <sup>1</sup> / <sub>8</sub>	75	113	150	225	300	375	450	525	600	675	750
8 <sup>1</sup> / <sub>4</sub>	77	115	154	230	307	384	461	537	614	691	768
8 <sup>3</sup> / <sub>8</sub>	79	118	157	236	314	393	471	550	628	707	785
8 <sup>1</sup> / <sub>2</sub>	80	120	161	241	321	401	482	562	642	722	803
8 <sup>5</sup> / <sub>8</sub>	82	123	164	246	328	410	492	574	656	739	821
8 <sup>3</sup> / <sub>4</sub>	84	126	168	252	335	419	503	587	671	755	838
8 <sup>7</sup> / <sub>8</sub>	86	128	171	257	343	428	514	599	685	771	856
9	87	131	175	262	350	437	525	612	700	788	875
9 <sup>1</sup> / <sub>8</sub> .....	134	179	268	357	440	536	625	714	804	893	
9 <sup>1</sup> / <sub>4</sub> .....	137	182	273	364	456	547	638	729	820	911	
9 <sup>3</sup> / <sub>8</sub> .....	139	186	279	372	465	558	651	744	837	930	
9 <sup>1</sup> / <sub>2</sub> .....	142	190	285	379	474	569	664	759	854	949	
9 <sup>5</sup> / <sub>8</sub> .....	145	193	290	387	484	580	677	774	861	967	
9 <sup>3</sup> / <sub>4</sub> .....	148	197	296	394	493	592	690	789	888	986	
9 <sup>7</sup> / <sub>8</sub> .....	151	201	302	402	503	603	704	804	905	1005	
10 .....	154	205	307	410	512	615	717	820	922	1024	
10 <sup>1</sup> / <sub>8</sub> .....	157	209	313	417	522	626	731	835	939	1044	
10 <sup>1</sup> / <sub>4</sub> .....	159	213	319	425	532	638	744	850	957	1063	
10 <sup>3</sup> / <sub>8</sub> .....	162	217	325	433	541	650	758	866	974	1083	
10 <sup>1</sup> / <sub>2</sub> .....	165	220	331	441	551	661	771	882	992	1102	
10 <sup>5</sup> / <sub>8</sub> .....		224	337	449	561	673	785	898	1010	1122	
10 <sup>3</sup> / <sub>4</sub> .....		228	342	457	571	685	799	913	1027	1142	
10 <sup>7</sup> / <sub>8</sub> .....		232	349	465	581	697	813	930	1046	1162	

TABLE 1. Discharges of Farmers' Weirs of Different lengths, expressed in Montana Miners' Inches.—CONTINUED.

Depth of water on crest.	1-foot weir.	1½-foot weir.	2-foot weir.	3-foot weir.	4-foot weir.	5-foot weir.	6-foot weir.	7-foot weir.	8-foot weir.	9-foot weir.	10-foot weir.
Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.
11	....	....	236	355	473	591	709	827	946	1064	1182
11⅓	....	....	240	361	481	601	721	841	962	1082	1202
11¼	....	....	244	367	489	611	733	856	978	1100	1222
11⅓	....	....	249	373	497	621	746	870	994	1119	1243
11½	....	....	253	379	505	632	758	884	1011	1137	1263
11⅝	....	....	257	385	514	642	770	899	1027	1156	1284
11¾	....	....	261	391	522	652	783	913	1044	1174	1305
11⅞	....	....	265	398	530	663	795	928	1060	1193	1327
12	....	....	269	404	539	673	808	943	1077	1212	1348
12⅓	....	....	....	410	547	684	821	958	1094	1231	1369
12¼	....	....	....	417	556	694	833	972	1111	1250	1391
12⅓	....	....	....	423	564	705	846	987	1128	1269	1403
12½	....	....	....	430	573	716	859	1002	1145	1289	1415
12⅝	....	....	....	436	582	726	872	1017	1162	1308	1428
12¾	....	....	....	442	590	737	885	1032	1180	1328	1441
12⅞	....	....	....	449	599	748	898	1048	1197	1348	1454
13	....	....	....	456	607	759	911	1063	1215	1368	1467
13⅓	....	....	....	462	616	770	924	1078	1232	1389	1480
13¼	....	....	....	469	625	781	938	1094	1250	1409	1493
13⅓	....	....	....	475	634	792	951	1109	1268	1429	1506
13½	....	....	....	482	643	803	964	1125	1286	1449	1519
13⅝	....	....	....	....	652	815	978	1140	1303	1469	1532
13¾	....	....	....	....	661	826	991	1156	1321	1489	1545
13⅞	....	....	....	....	670	837	1005	1172	1340	1509	1558
14	....	....	....	....	679	849	1019	1189	1359	1530	1571
14⅓	....	....	....	....	688	860	1032	1204	1376	1550	1584
14¼	....	....	....	....	697	871	1046	1220	1394	1570	1597
14⅓	....	....	....	....	706	883	1059	1236	1412	1590	1610
14½	....	....	....	....	715	894	1073	1252	1431	1610	1623

# FARMERS' WEIRS.

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TABLE 1. Discharges of Farmers' Weirs of different lengths, expressed in Montana Miners' Inches.—CONTINUED.

Depth of water on crest.	1-foot weir.	1½-foot weir.	2-foot weir.	3-foot weir.	4-foot weir.	5-foot weir.	6-foot weir.	7-foot weir.	8-foot weir.	9-foot weir.	10-foot weir.
Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.	Miners' Inches.
14⅝	.....	.....	.....	.....	725	906	1087	1268	1449	1631	1812
14¾	.....	.....	.....	.....	734	918	1101	1285	1468	1652	1835
14⅞	.....	.....	.....	.....	743	929	1115	1301	1487	1673	1859
15	.....	.....	.....	.....	753	941	1129	1317	1506	1694	1882
15⅛	.....	.....	.....	.....	.....	953	1143	1334	1524	1715	1906
15¼	.....	.....	.....	.....	.....	965	1158	1351	1543	1736	1929
15⅝	.....	.....	.....	.....	.....	977	1172	1368	1562	1757	1953
15½	.....	.....	.....	.....	.....	989	1186	1385	1580	1778	1977
15⅞	.....	.....	.....	.....	.....	1001	1201	1402	1600	1801	2001
15¾	.....	.....	.....	.....	.....	1013	1215	1419	1620	1822	2025
15⅞	.....	.....	.....	.....	.....	1025	1229	1437	1639	1844	2049
16	.....	.....	.....	.....	.....	1037	1244	1455	1659	1866	2073
16⅛	.....	.....	.....	.....	.....	1049	1259	1472	1678	1888	2098
16¼	.....	.....	.....	.....	.....	1061	1273	1489	1698	1910	2122
16⅝	.....	.....	.....	.....	.....	1073	1288	1506	1717	1932	2147
16½	.....	.....	.....	.....	.....	1086	1303	1523	1737	1954	2171
16⅞	.....	.....	.....	.....	.....	1098	1318	1539	1757	1976	2196
16¾	.....	.....	.....	.....	.....	1110	1333	1556	1777	1999	2221
16⅞	.....	.....	.....	.....	.....	1123	1348	1572	1797	2021	2246
17	.....	.....	.....	.....	.....	1135	1363	1589	1817	2044	2271
17⅛	.....	.....	.....	.....	.....	.....	1378	1607	1837	2066	2296
17¼	.....	.....	.....	.....	.....	.....	1393	1625	1857	2089	2321
17⅝	.....	.....	.....	.....	.....	.....	1408	1642	1877	2112	2346
17½	.....	.....	.....	.....	.....	.....	1423	1660	1897	2134	2372
17⅞	.....	.....	.....	.....	.....	.....	1438	1678	1918	2157	2397
17¾	.....	.....	.....	.....	.....	.....	1454	1696	1938	2181	2423
17⅞	.....	.....	.....	.....	.....	.....	1469	1714	1959	2204	2448
18	.....	.....	.....	.....	.....	.....	1484	1732	1979	2226	2474

TABLE II.—Discharges of Cippoletti Weirs of different lengths, computed from the formula  $Q=3.3\frac{3}{8} LH^{\frac{3}{2}}$ 

Depth of water on crest.	1-foot weir.	1½ foot weir.	2-foot weir.	3-foot weir.	4-foot weir.	5-foot weir.	6-foot weir.	7-foot weir.	8-foot weir.	9-foot weir.	10-foot weir.
Feet	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.
0.01	0.0034	0.0051	0.0067	0.0101	0.0135	0.0168	0.0202	0.0236	0.0269	0.0303	0.0337
0.02	0.0065	0.0143	0.0180	0.0286	0.0381	0.0476	0.0571	0.0667	0.0762	0.0857	0.0952
0.03	0.0173	0.0262	0.0350	0.0525	0.0700	0.0875	0.1050	0.1225	0.1400	0.1574	0.1749
0.04	0.0299	0.0404	0.0559	0.0808	0.1077	0.1347	0.1616	0.1885	0.2153	0.2424	0.2693
0.05	0.0376	0.0565	0.0753	0.1129	0.1506	0.1882	0.2258	0.2635	0.3011	0.3388	0.3764
0.06	0.0495	0.0712	0.0980	0.1484	0.1979	0.2474	0.2969	0.3464	0.3958	0.4453	0.4948
0.07	0.0624	0.0885	0.1247	0.1871	0.2494	0.3118	0.3741	0.4365	0.4988	0.5612	0.6235
0.08	0.0762	0.1143	0.1524	0.2285	0.3047	0.3809	0.4571	0.5333	0.6095	0.6856	0.7618
0.09	0.0909	0.1364	0.1818	0.2727	0.3636	0.4545	0.5454	0.6363	0.7272	0.8181	0.9090
0.10	0.1065	0.1597	0.2129	0.3194	0.4259	0.5323	0.6388	0.7452	0.8517	0.9582	1.0646
0.11	0.1228	0.1842	0.2457	0.3685	0.4913	0.6141	0.7370	0.8598	0.9826	1.1054	1.2283
0.12	0.1399	0.2069	0.2799	0.4198	0.5598	0.6997	0.8397	0.9796	1.1190	1.2585	1.3985
0.13	0.1578	0.2367	0.3156	0.4734	0.6312	0.7890	0.9468	1.1046	1.2624	1.4202	1.5780
0.14	0.1764	0.2645	0.3527	0.5291	0.7054	0.8818	1.0581	1.2345	1.4108	1.5872	1.7636
0.15	0.1956	0.2934	0.3912	0.5868	0.7823	0.9779	1.1735	1.3691	1.5647	1.7603	1.9559
0.16	0.2153	0.3232	0.4309	0.6464	0.8619	1.0773	1.2928	1.5083	1.7237	1.9392	2.1547
0.17	0.2360	0.3540	0.4720	0.7079	0.9439	1.1799	1.4159	1.6519	1.8878	2.1238	2.3598
0.18	0.2571	0.3857	0.5142	0.7713	1.0284	1.2855	1.5426	1.7997	2.0568	2.3139	2.5710
0.19	0.2788	0.4182	0.5576	0.8354	1.1153	1.3941	1.6729	1.9518	2.2306	2.5094	2.7882
0.20	0.3011	0.4517	0.6022	0.9035	1.2045	1.5055	1.8068	2.1079	2.4080	2.7101	3.0122
0.21	0.3240	0.4860	0.6490	0.9720	1.2960	1.6169	1.9439	2.2679	2.5919	2.9159	3.2399
0.22	0.3474	0.5211	0.6948	1.0422	1.3896	1.7370	2.0844	2.4318	2.7742	3.1266	3.4740
0.23	0.3714	0.5570	0.7427	1.1141	1.4854	1.8368	2.2281	2.5865	2.9709	3.3422	3.7186
0.24	0.3958	0.5938	0.7917	1.1875	1.5834	1.9792	2.3750	2.7709	3.1667	3.5625	3.9584
0.25	0.4208	0.6312	0.8417	1.2625	1.6833	2.1042	2.5250	2.9458	3.3666	3.7875	4.2083
0.26	0.4463	0.6695	0.8927	1.3390	1.7853	2.2317	2.6780	3.1243	3.5707	4.0170	4.4633
0.27	0.4723	0.7085	0.9447	1.4170	1.8893	2.3617	2.8340	3.3033	3.7787	4.2510	4.7238
0.28	0.4988	0.7482	0.9976	1.4964	1.9952	2.4941	2.9929	3.4917	3.9905	4.4833	4.9881
0.29	0.5258	0.7887	1.0515	1.5775	2.1031	2.6289	3.1546	3.6804	4.2062	4.7319	5.2577
0.30	0.5532	0.8298	1.1064	1.6599	2.2128	2.7690	3.3192	3.8724	4.4256	4.9788	5.5320
0.31	0.5811	0.8716	1.1622	1.7433	2.3244	2.9054	3.4865	4.0676	4.6487	5.2268	5.8108
0.32	0.6094	0.9141	1.2189	1.8283	2.4377	3.0472	3.6596	4.2690	4.8734	5.4849	6.0845
0.33	0.6382	0.9573	1.2764	1.9147	2.5529	3.1911	3.8293	4.4675	5.1058	5.7440	6.3622
0.34	0.6674	1.0012	1.3349	2.0023	2.6698	3.3372	4.0047	4.6721	5.3386	6.0070	6.6745
0.35	0.6971	1.0457	1.3942	2.0913	2.7884	3.4836	4.1827	4.8798	5.5769	6.2740	6.9711
0.36	0.7272	1.0908	1.4544	2.1816	2.9088	3.6360	4.3632	5.0804	5.8176	6.5488	7.2720
0.37	0.7577	1.1366	1.5154	2.2731	3.0308	3.7885	4.5463	5.3040	6.0617	6.8194	7.5771
0.38	0.7886	1.1830	1.5773	2.3659	3.1545	3.9432	4.7318	5.5204	6.3091	7.0977	7.8963
0.39	0.8200	1.2300	1.6399	2.4599	3.2799	4.0998	4.9198	5.7398	6.5587	7.3797	8.1897
0.40	0.8517	1.2776	1.7034	2.5551	3.4038	4.2585	5.1102	5.9619	6.8137	7.6654	8.5171
0.41	0.8838	1.3258	1.7677	2.6515	3.5354	4.4192	5.3031	6.1869	7.0708	7.9546	8.8384
0.42	0.9164	1.3746	1.8328	2.7491	3.6655	4.5819	5.4983	6.4146	7.3310	8.2474	9.1638
0.43	0.9493	1.4239	1.8986	2.8479	3.7972	4.7465	5.6953	6.6451	7.5944	8.5437	9.4930
0.44	0.9826	1.4739	1.9652	2.9478	3.9304	4.9130	5.8956	6.8782	7.8608	8.8434	9.8261
0.45	1.0163	1.5244	2.0326	3.0489	4.0652	5.0815	6.0978	7.1141	8.1303	9.1466	10.1629
0.46	1.0504	1.5755	2.1007	3.1511	4.2014	5.2518	6.3021	7.3525	8.4029	9.4532	10.5009
0.47	1.0848	1.6272	2.1696	3.2544	4.3392	5.4240	6.5088	7.5936	8.6753	9.7631	10.8479
0.48	1.1196	1.6794	2.2392	3.3588	4.4784	5.5980	6.7178	7.8372	8.9567	10.0764	11.1960
0.49	1.1548	1.7321	2.3095	3.4643	4.6191	5.7738	6.9296	8.0834	9.2381	10.3929	11.5477
0.50	1.1903	1.7854	2.3806	3.5709	4.7612	5.9515	7.1418	8.3321	9.5224	10.7127	11.9030
0.51	.....	1.8393	2.4524	3.6785	4.9047	6.1309	7.3571	8.5833	9.8085	11.0356	12.2618
0.52	.....	1.8936	2.5248	3.7873	5.0497	6.3121	7.5745	8.8370	10.0864	11.3618	12.6242
0.53	.....	1.9485	2.5980	3.8970	5.1961	6.4951	7.7941	9.0931	10.3921	11.6911	12.9901
0.54	.....	2.0039	2.6719	4.0079	5.3438	6.6798	8.0157	9.3517	10.6876	12.0236	13.3585
0.55	.....	2.0598	2.7465	4.1197	5.4959	6.8642	8.2394	9.6126	10.9859	12.3591	13.7233
0.56	.....	2.1163	2.8217	4.2325	5.6434	7.0513	8.4651	9.8760	11.2868	12.6977	14.0885
0.57	.....	2.1732	2.8976	4.3464	5.7953	7.2441	8.6929	10.1417	11.5905	13.0383	14.4581
0.58	.....	2.2307	2.9742	4.4613	5.9484	7.4355	8.9226	10.4077	11.8989	13.3840	14.8311
0.59	.....	2.2886	3.0515	4.5772	6.1029	7.6287	9.1544	10.6801	12.2059	13.7613	15.2073
0.60	.....	2.3470	3.1294	4.6940	6.2587	7.8234	9.3881	10.9527	12.5174	14.0621	15.6468
0.61	.....	2.4059	3.2079	4.8119	6.4159	8.0198	9.6238	11.2278	12.8317	14.4357	16.0966

TABLE II.—Discharges of Cippoletti Weirs of different lengths computed from the Formula  $Q=3.3\frac{1}{2} LH^{\frac{3}{2}}$ —CONTINUED.

Depth of water on crest.	1-foot weir.	1½-foot weir.	2-foot weir.	3-foot weir.	4-foot weir.	5-foot weir.	6-foot weir.	7-foot weir.	8-foot weir.	9-foot weir.	10-foot weir.
Feet.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.	Cu. ft. per sec.
0.62	2.4654	3.2871	4.9807	6.5743	8.2178	9.8614	11.5050	13.1486	14.7921	16.4357	18.0793
0.63	2.5232	3.3670	5.0505	6.7340	8.4175	10.1009	11.7844	13.4679	15.1514	16.8349	18.5184
0.64	2.5856	3.4475	5.1712	6.8949	8.6187	10.3424	12.0661	13.7899	15.5136	17.2373	18.9609
0.65	2.6484	3.5286	5.2929	7.0572	8.8215	10.5857	12.3500	14.1143	15.8786	17.6429	19.4056
0.66	2.7077	3.6103	5.4155	7.2206	9.0258	10.8310	12.6361	14.4413	16.2465	18.0516	19.8161
0.67	2.7685	3.6927	5.5390	7.3854	9.2317	11.0781	12.9244	14.7707	16.6171	18.4634	20.2283
0.68	2.8317	3.7757	5.6635	7.5513	9.4392	11.3270	13.2148	15.1027	16.9905	18.8783	20.6429
0.69	2.8944	3.8583	5.7889	7.7185	9.6481	11.5778	13.5074	15.4370	17.3667	19.2983	21.0593
0.70	2.9576	3.9435	5.9152	7.8869	9.8586	11.8304	13.8021	15.7738	17.7456	19.7173	21.4773
0.71	3.0212	4.0283	6.0424	8.0565	10.0706	12.0848	14.0989	16.1120	18.1272	20.1413	21.8963
0.72	3.0852	4.1137	6.1705	8.2273	10.2842	12.3410	14.3678	16.4547	18.5115	20.5693	22.3163
0.73	3.1497	4.1997	6.2965	8.3983	10.4992	12.5990	14.6388	16.7989	18.8985	20.9983	22.7373
0.74	3.2147	4.2863	6.4294	8.5725	10.7156	12.8588	15.0019	17.1450	19.2881	21.4313	23.1593
0.75	3.2801	4.3734	6.5601	8.7469	10.9336	13.1203	15.3070	17.4937	19.6804	21.8671	23.5829
0.76	4.4612	6.6018	8.9224	11.1530	13.3836	15.6142	17.8447	20.0753	22.3059	24.6809	26.9889
0.77	4.5495	6.8243	9.0691	11.3728	13.6486	15.9233	18.1981	20.4729	22.7476	25.1476	27.4516
0.78	4.6384	6.9577	9.2769	11.5961	13.9153	16.2345	18.5538	20.8790	23.1922	25.6063	27.9163
0.79	4.7279	7.0919	9.4559	11.8198	14.1838	16.5477	18.9117	21.2757	23.6396	26.0683	28.3829
0.80	4.8180	7.2270	9.6360	12.0450	14.4539	16.8629	19.2719	21.6809	24.0899	26.5309	28.8509
0.81	4.9086	7.3629	9.8172	12.2715	14.7258	17.1801	19.6344	22.0887	24.5430	26.9959	29.3169
0.82	4.9996	7.4997	9.9996	12.4995	14.9993	17.4992	19.9991	22.4990	25.0009	27.4729	29.7889
0.83	5.0915	7.6373	10.1830	12.7288	15.2746	17.8202	20.3661	22.9118	25.4576	27.9476	30.2569
0.84	5.1838	7.7757	10.3676	12.9595	15.5514	18.1433	20.7352	23.3271	25.9191	28.4163	30.7269
0.85	5.2767	7.9150	10.5533	13.1916	15.8300	18.4683	21.1066	23.7449	26.3833	28.8863	31.1989
0.86	5.3700	8.0551	10.7401	13.4251	16.1101	18.7952	21.4802	24.1632	26.8502	29.3569	31.6729
0.87	5.4640	8.1960	10.9280	13.6589	16.3919	19.1239	21.8559	24.5879	27.3199	29.8309	32.1489
0.88	5.5585	8.3377	11.1169	13.8961	16.6754	19.4546	22.2338	25.0131	27.7923	30.3069	32.6269
0.89	5.6535	8.4802	11.3069	14.1337	16.9604	19.7872	22.6139	25.4406	28.2674	30.7849	33.1069
0.90	5.7490	8.6235	11.4980	14.3726	17.2470	20.1216	22.9961	25.8706	28.7451	31.2649	33.5889
0.91	5.8451	8.7677	11.6902	14.6128	17.5333	20.4579	23.3804	26.3030	29.2255	31.7469	34.0729
0.92	5.9417	8.9128	11.8834	14.8543	17.8251	20.7960	23.7669	26.7377	29.7086	32.2309	34.5589
0.93	6.0389	9.0583	12.0777	15.0971	18.1166	21.1360	24.1554	27.1748	30.1943	32.7169	35.0469
0.94	6.1365	9.2048	12.2730	15.3413	18.4096	21.4778	24.5461	27.6143	30.6826	33.2049	35.5369
0.95	6.2347	9.3520	12.4694	15.5867	18.7041	21.8214	24.9388	28.0561	31.1735	33.6949	36.0289
0.96	6.3334	9.5001	12.6668	15.8335	19.0002	22.1669	25.3336	28.5003	31.6670	34.1869	36.5229
0.97	6.4326	9.6489	12.8652	16.0815	19.2979	22.5142	25.7305	28.9468	32.1631	34.6809	37.0189
0.98	6.5323	9.7985	13.0647	16.3309	19.5970	22.8632	26.1294	29.3956	32.6617	35.1769	37.5169
0.99	6.6326	9.9489	13.2652	16.5815	19.8978	23.2141	26.5303	29.8467	33.1629	35.6729	38.0169
1.00	6.7333	10.1000	13.4667	16.8333	20.2000	23.5667	26.9333	30.3000	33.6667	36.1729	38.5189
1.01	.....	.....	.....	.....	.....	20.5038	23.9211	27.3384	30.7556	34.1729	39.0229
1.02	.....	.....	.....	.....	.....	20.8090	24.2772	27.7454	31.2135	34.6817	39.5289
1.03	.....	.....	.....	.....	.....	21.1158	24.6351	28.1544	31.6737	35.1930	40.0369
1.04	.....	.....	.....	.....	.....	21.4240	24.9947	28.5654	32.1361	35.7067	40.5469
1.05	.....	.....	.....	.....	.....	21.7338	25.3561	28.9784	32.6007	36.2230	41.0589
1.06	.....	.....	.....	.....	.....	22.0450	25.7192	29.3833	33.0675	36.7417	41.5729
1.07	.....	.....	.....	.....	.....	22.3577	26.0840	29.8103	33.5365	37.2623	42.0889
1.08	.....	.....	.....	.....	.....	22.6719	26.4505	30.2291	34.0078	37.7864	42.6069
1.09	.....	.....	.....	.....	.....	22.9875	26.8187	30.6499	34.4812	38.3124	43.1269
1.10	.....	.....	.....	.....	.....	23.3045	27.1886	31.0727	34.9568	38.8409	43.6489
1.11	.....	.....	.....	.....	.....	23.6230	27.5602	31.4974	35.4346	39.3717	44.1729
1.12	.....	.....	.....	.....	.....	23.9430	27.9335	31.9240	35.9145	39.9050	44.7009
1.13	.....	.....	.....	.....	.....	24.2644	28.3084	32.3525	36.3965	40.4406	45.2309
1.14	.....	.....	.....	.....	.....	24.5872	28.6850	32.7829	36.8808	40.9786	45.7629
1.15	.....	.....	.....	.....	.....	24.9114	29.0633	33.2152	37.3671	41.5190	46.2969
1.16	.....	.....	.....	.....	.....	25.2370	29.4432	33.6494	37.8556	42.0617	46.8329
1.17	.....	.....	.....	.....	.....	25.5641	29.8248	34.0854	38.3461	42.6068	47.3709
1.18	.....	.....	.....	.....	.....	25.8925	30.2079	34.5234	38.8388	43.1542	47.9109
1.19	.....	.....	.....	.....	.....	26.2224	30.5928	34.9631	39.3335	43.7039	48.4529
1.20	.....	.....	.....	.....	.....	26.5536	30.9792	35.4048	39.8304	44.2560	48.9969
1.21	.....	.....	.....	.....	.....	.....	31.3672	35.8483	40.3293	44.8103	49.5429
1.22	.....	.....	.....	.....	.....	.....	31.7569	36.2936	40.8303	45.3670	50.0909
1.23	.....	.....	.....	.....	.....	.....	32.1481	36.7407	41.3333	45.9259	50.6409







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BULLETIN NO. 35.

**MONTANA AGRICULTURAL**

# **Experiment Station**

**OF THE**

**AGRICULTURAL COLLEGE OF MONTANA.**

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## **Report of Feeding Tests.**

**BEEF CATTLE AND SHEEP.**

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**I. COMPARATIVE RESULTS FROM FEEDING LAMBS, 1-YEAR  
WETHERS, 2-YEAR WETHERS AND AGED EWES.**

**II. FATTENING STEERS WITH DIFFERENT QUANTITIES OF GRAIN.**

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**BOZEMAN, MONTANA, MAY 1, 1902.**

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**1902.  
The Avant Courier Publishing Co.,  
Bozeman, Montana.**

# Montana Agricultural Experiment Station

Bozeman, Montana.

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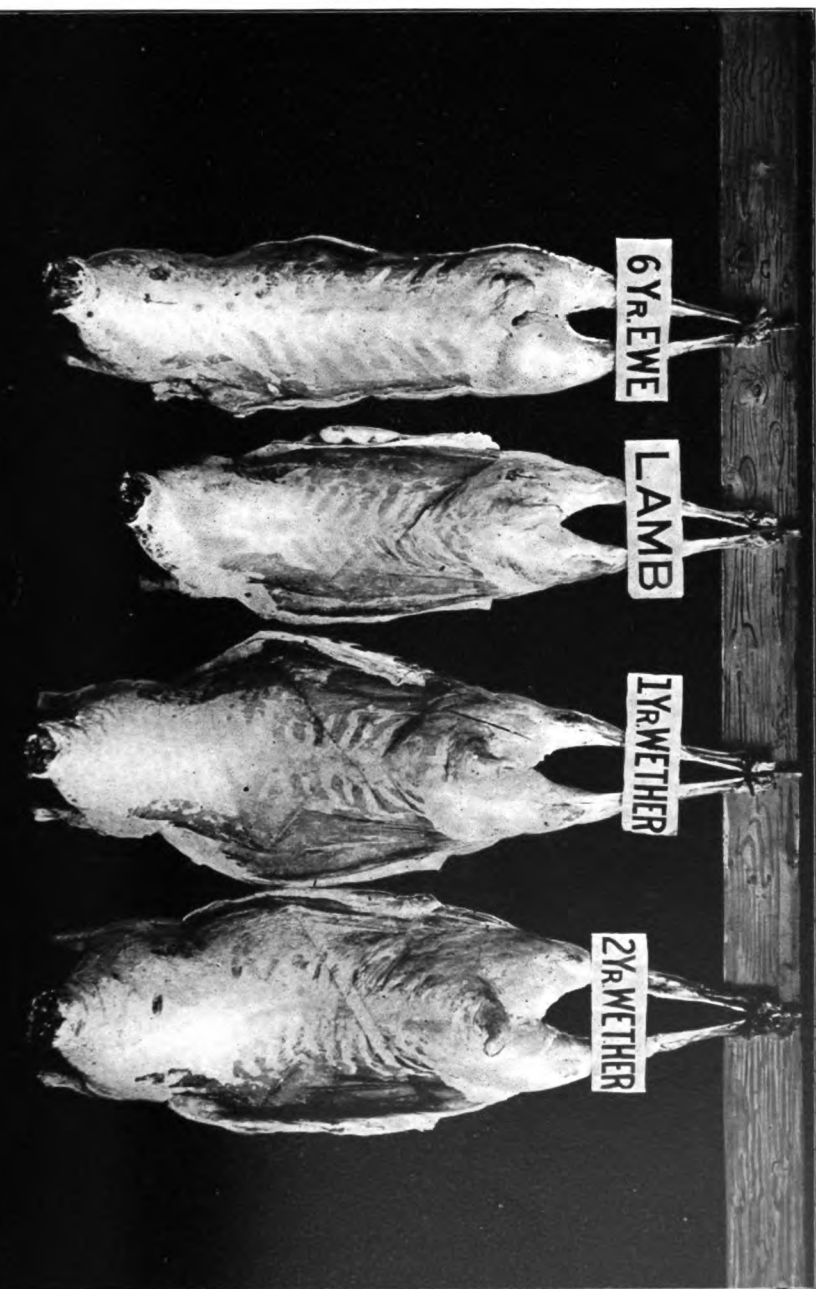
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Fattened by the Montana Experiment Station, 1902.

# Montana Experiment Station.

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Bulletin No. 35.

May 1902.

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BY R. S. SHAW.

## SHEEP FEEDING.

### COMPARATIVE TESTS WITH LAMBS, YEARLING WETHERS, TWO-YEAR WETHERS, AND AGED EWES.

The primary object of this work during the past season was to secure data concerning the relative profits from feeding sheep of different ages for market. In procuring this data secondary determinations were made demonstrating many practical requirements and results in a comparative way along the following lines, viz:

(1) Amount of food required, per head, daily. (2) Relation of grain to coarse food for sheep of different ages. (3) Actual and percentage gains in live weight. (4) Air dry food necessary per pound increase. (5) Relative cost of food and increase. (6) Relative profits. (7) Report of slaughter test. (8) Shrinkage in transit.

This work was found to be necessary because of the rapidly increasing interest which is being manifested throughout the state in fitting sheep for market. Because of climatic conditions peculiar to the arid west and the kind and quality of its product, determinations even of the simplest and most practical character must be made

For the purpose of these experiments, four lots consisting of wether lambs, yearling wethers, two-year wethers, and ewes were purchased for the Station, in Oct., 1902, by J. M. Mason. The object in selection was to secure animals presenting uniformity in blood characters and the average of Montana range production. These sheep were purchased by the head, at the following prices: Lambs, \$1.62; yearlings, \$2.50; two-year-olds, \$2.60; aged ewes, \$2.50. The average weights when feeding began were: Lambs, 62.9 lbs.; yearlings, 94.9 lbs.; two years, 115.7 lbs.; and aged ewes, 91.6 lbs. The sheep had the run of the farm for a few days before being put on feed. The feeding period began Nov. 22d, 1902, and closed February 17th, 1903, thus extending over a period of 87 days. The same kinds of food were used in each case and under similar conditions. The four lots were fed in yards, side by side, using racks for the hay and troughs for grain. The sheep had constant access to sheds and water which ran through the yards. Owing to the generally favorable climatic conditions, the sheds were not used for the sheep more than a few days when the protection was badly needed.

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### Total Food Consumed and Cost of Same.

feeding period began Nov. 22d, 1901 and ended Feb. 17, 1902,  
 being 88 days.

lamb consumed 9958 lbs. clover, @ \$5.00 ton.....	\$24.89
lamb consumed 3304 lbs. barley, @ 90c per cwt.....	<u>29.73</u>
Total.....	\$54.62
4 wethers consumed 16,960 lbs. clover, @ \$5.00 per ton..	\$42.40
4 wethers consumed 3073 lbs. barley, @ 90c per cwt....	<u>\$27.65</u>
Total.....	\$70.05
4 wethers consumed 18,905 lbs. clover, @ \$5.00 per ton..	\$47.26
4 wethers consumed 3195 lbs. barley, @ 90c per cwt....	<u>28.75</u>
Total.....	\$76.01
4 ewes consumed 10,904 lbs. clover, @ \$5.00 per ton.....	\$47.26
4 ewes consumed 3195 lbs. barley, @ 90c per cwt.....	<u>28.75</u>
Total.....	\$56.01

The figures given above represent the actual amounts of food consumed, the percentage of waste having been deducted. While the method is to feed without waste, under conditions such as these must be taken into account in making accurate determinations. In such close feeding is practiced that there is absolutely no waste, the gains will be somewhat affected as the ration in part becomes forced. The coarser and less edible the food the greater will be the loss. Under ordinary conditions, with the quality of foods that can be produced in Montana when properly cured, the loss should not exceed two or three per cent.

In this case the coarse food consisted of first and second crop timothy hay. In general the quality was good, though a small amount was discolored in the stack. It had been cut in the first stages of maturity.

The grain food consisted exclusively of Chevalier barley and was grown on ground in every case. While some question has arisen as

to whether better results would have been obtained had this grain been ground, there was no evidence to show that it was not perfectly masticated and digested. The ewe mouths were examined and found to be in fairly good condition with one exception only. A combination of grains was not used because of the fact that many of our feeders will of necessity be forced to use some one kind. Both wheat and oats have been used separately along with clover in previous tests. Good results have been secured from all three, with a slight gain in favor of oats, with wheat and barley about equal and very close to the oats in gains. The oats have proved to be far the most expensive food of the three, owing to local prices.

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#### Food Consumed Per Head Per Day.

Lambs.....	Clover, 2.05 lbs.	Barley, .68 lbs.	Total, 2.73 lbs.
1-year Wethers...	Clover, 3.77 lbs.	Barley, .68 lbs.	Total, 4.45 lbs.
2-year Wethers...	Clover, 4.05 lbs.	Barley, .68 lbs.	Total, 4.73 lbs.
Aged Ewes.....	Clover, 2.33 lbs.	Barley, .68 lbs.	Total, 3.01 lbs.

The figures given above represent the average daily consumption of hay and grain and also the average amount of total dry matter used per head throughout the 88 days. In the case of the lambs the amount of food actually consumed per head, per day, is a little less than we had expected. Under similar conditions, in previous tests, about three pounds has been required for a daily ration and the feeder should figure on no less than that amount in making estimates of the food required by large bands.

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#### Relation of Grain to Coarse Food.

From the foregoing data we find the following relation to exist between the grain and the coarse food:

In Lamb ration.....	24 per cent consisted of grain.
In 1-year Wether ration.....	15 per cent consisted of grain.
In 2-year Wether ration.....	14 per cent consisted of grain.
In Aged Ewe ration.....	22 per cent consisted of grain.

is relation of grain and coarse food (clover) was planned in to give the four lots of different ages a uniform finish for the et. In the case of the lambs the largest percentage of grain given, not as being necessary to produce a large increase in ht, but to give the carcass fatness; the tendency in the lamb to an increase of a growthy nature rather than fat. The weth-being practically mature sheep, were supplied a smaller percent- of grain as the increase in live weight is mostly fat. It is on this that we advocate the fattening of lambs only, when some grain e used, and the selection of wethers where alfalfa or clover only available. The larger ration of grain was furnished the ewes be- e of poor condition and vitiated digestive and assimilative rs.

ention is especially called to the results secured in these experi- s where grain forms less than one quarter of the ration. It is through the use of legumes such as red clover, alsike and alfalfa, such results can be secured. Where carbonaceous coarse foods as native hays, corn fodder, sorghum, etc., are used, then the must form one half to two thirds of the ration in order to e equivalent gains.

### Weights and Increase in 88 Days from Food Fed.

VARIOUS LOTS.	Weight Nov. 22d, 1902.....	Average.....	Weight Feb. 17, 1902.....	Average.....	Total Gain.....	Gain Per Head.....	Gain P-r Month.....	Percentage of Increase.....
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	per ct.
Lambs.....	3459	62.9	4764	86.6	1305	23.7	8.08	37.7
1-year Wethers...	4840	94.9	6040	118.4	1200	23.5	8.01	24.7
2-year Wethers..	6133	115.7	7420	140.	1287	24.3	8.28	20.9
aged Ewes.....	4858	91.6	5684	107.2	826	15.6	5.31	17.

The weights above given were neither secured from the animals under full feed nor yet under a shrinkage. The practice followed was to weigh from eight to nine hours after the morning feed. The weights were taken every two weeks but owing to the uniformity in these the final results only are reported. Attention is particularly called to the column above giving the percentage increase in weight. With the exception of the ewes the gains per head for 88 days, as well as the gains per month, appear to be quite satisfactory and until presented in a way in which comparison is made clear, the differences are not so manifest. The percentage increase added to the original live weight was as follows: 1-yr. wethers 37 per cent, 1-yr. wethers 24.7 per cent, 2-yr. wethers 20.9 per cent and aged ewes 17 per cent.

#### Amount of Air Dry Food Consumed Per Pound Increase in Weight.

##### Maintenance.

Lambs.....Dry food consumed per pound gain, 10.0  
 1-yr. Wethers.....Dry food consumed per pound gain, 16.0  
 2-yr. Wethers.....Dry food consumed per pound gain, 17.0  
 Aged Ewes.....Dry food consumed per pound gain, 17.0

Owing to the small proportion of grain in the ration, viz.: 1/4 per head per day, the total amount of dry food required to produce a pound of gain is larger than where more grain is used. In previous experiments where about one pound of grain was used in the ration for lambs, along with clover, only 8.75 pounds of dry food was required to produce a pound of increase.

In the above, the comparison between the lambs and ewes is made on an equal basis, but in the case of the wethers the proportion of hay is greater, consequently, the amounts given for them are a little high in comparison.

### Relative Cost of Production.

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s.....Cost per 100 pounds increase in live weight, \$4.18  
 Wethers.....Cost per 100 pounds increase in live weight, 5.83  
 Wethers.....Cost per 100 pounds increase in live weight, 5.90  
 Ewes.....Cost per 100 pounds increase in live weight, 6.78

The cost of production is a matter which of course materially affects the financial results. In the figures given above we find a more striking illustration of the fact that the younger the lamb the less will be the cost of increase in live weight produced.

And then in referring to the sale statement, we find the value of the lamb given is in about an inverse proportion to the age of the lamb.

Attention is called here to the fact that an accurate comparison can only be made between the lambs and ewes, as about the same relationship existed in these two cases between the grain and coarse feed.

The lamb and ewe rations contained 24 and 22 per cent of grain respectively, while the wether rations contained only 14 and 12 per cent of grain. As the grain, however, was worth about 1 cent per pound and the clover  $\frac{1}{4}$  cent per pound, this difference in price amounts to about even things up in the case of the wethers.

### Per Capita Cost of Food Consumed.

---

s, value of food consumed per head during 88 days, \$ .99  
 Wethers, value of food consumed per head during 88 days, 1.37  
 Wethers, value of food consumed per head during 88 days, 1.43  
 Ewes.. value of food consumed per head during 88 days, 1.05

### Financial Statement.

#### LAMBS.

Nov. 22, 1901, To 55 lambs at \$1.62½ per head, ....	\$ 89.37	
Feb. 17, 1902, To cost of feed for 88 days .....	54.62	
Feb. 25, 1902, To cost of shipping .....	42.96	
Feb. 25, 1902, By 55 lambs, 4340 lbs. at \$6.50 per cwt.		\$282.10
Feb. 25, 1902, To net profit .....	95.15	
	<u>\$282.10</u>	<u>\$282.10</u>

#### 1-YEAR WETHERS.

Nov. 22, 1901, To 51 1-yr. wethers at \$2.50 per head...	\$127.50	
Feb. 17, 1902, To cost of feed for 88 days .....	70.05	
Feb. 25, 1902, To cost of shipping .....	54.84	
Feb. 25, 1902, By 51 wethers, 5540 lbs. at \$5.85 cwt.		\$324.09
Feb. 25, 1902, To net profit .....	71.70	
	<u>\$324.09</u>	<u>\$324.09</u>

#### 2-YEAR WETHERS.

Nov. 22, 1901, To 53 2-yr. wethers at \$2.65 per head...	\$140.45	
Feb. 17, 1902, To cost of food for 88 days .....	76.01	
Feb. 25, 1902, To cost of shipping .....	67.30	
Feb. 25, 1902, By 53 wethers, 6800 lbs. at \$5.40 cwt.		\$367.20
Feb. 25, 1902, To net profit .....	83.44	
	<u>\$367.20</u>	<u>\$367.20</u>

#### AGED EWES.

Nov. 22, 1901, To 53 ewes at \$2.50 per head .....	\$132.50	
Feb. 17, 1902, To cost of food for 88 days .....	56.01	
Feb. 25, 1902, To cost of shipping .....	49.89	
Feb. 25, 1902, By 53 ewes, 5040 lbs. at \$4.75 cwt.		\$239.40
Feb. 25, 1902, To net profit .....	1.00	
	<u>\$239.40</u>	<u>\$239.40</u>

In determining the relative profits from each of the four lots it was necessary to divide the expense of shipping, consisting of freight charges, feed, commission, etc. This was done on the basis of weights, as the two most important features of expense, freight and feed, are in proportion to weight. Owing to stop-overs for feeding the expenses in this case were considerably above the average, which prevents our profits from being still larger.

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**Relative Profits From the Four Lots.**

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lambs gave a net profit of \$95.15 or \$1.73 per head.  
1-year wethers gave a net profit of \$71.70 or \$1.40 per head.  
2-year wethers gave a net profit of \$83.44 or \$1.57 per head.  
aged ewes gave a net profit of \$1.00, or 1.8 cents per head.  
The figures given above do not represent the total profits. The  
was charged up at \$5 per ton and grain at 90 cents per cwt.  
prices being above cost of production, a secondary profit oc-  
curs here which is not considered in the data. It is the custom  
in feeding experiments to offset the cost of labor by the value of  
manure left on the farm to maintain fertility. The greater profit  
of the two-year wethers as compared with the yearlings is due  
to the purchase prices. While 94.9 lb. yearlings cost \$2.50, 115.7 lb.  
year olds were purchased at \$2.65.

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**Report of Slaughter Test, by Swift & Co. of Chicago.**

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lambs, average 79 lbs., \$6.50, dress 54.2 per cent.  
1-year wethers, average 108 lbs., \$5.85, dress 52.9 per cent.  
2-year wethers, average 128 lbs., \$5.40, dress 53.5 per cent.  
ewes, average 95 lbs., \$4.75, dress 50.6 per cent.  
We consider all of these sheep and lambs a useful class of stock,  
too fat, and they dress about 2 per cent above the average com-  
ing to the Chicago market at the present time."  
The percentage of dressed weight is figured on a basis of actual  
weight immediately after killing, shrunk 3 per cent, which is about  
the mutton will shrink after hanging over night."

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**Shrinkage.**

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This was determined from weights when sheep were taken off  
on February 17th and the weights given in sale bill from  
ago February 24th.

Lambs shrunk 7.6 lbs. or 8.7 per cent.

1-year wethers shrunk 10.4 lbs. or 8.7 per cent.

2-year wethers shrunk 12. lbs. or 8.5 per cent.

Aged ewes shrunk 12.2 lbs. or 11.3 per cent.

For the benefit of those interested in shipping and that the figures relating to shrinkage may be better understood, we give the following detailed account of the trip, as provided by Mr. Robinson, who accompanied the shipment. The sheep left Bozeman about noon of the 18th of February and arrived at Mandan on the 19th at 3 p. m., where they were fed hay only. Left Mandan at noon on 20th and arrived in St. Paul at 5:30 a. m. 21st, where the sheep received a grain ration with the hay. Left St. Paul at noon 23d and reached Chicago at 4 a. m. 24th. The sheep were weighed and sold at 10 a. m. The time actually in transit was three days and four nights. Mr Robinson suggests that it would be of material interest to shippers to stop and feed at a point nearer Chicago.

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### Cost of Marketing.

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This includes all expense of shipping, such as transportation, yardage, feed, commission, etc. As before stated, these expenses were divided in proportion to the weights of the four lots in determining the relative profits from each, on the basis that freight tariff is the same per pound and that the food consumed while in transit is in proportion to the weight of the animals. On this basis, we get the following relative cost of marketing:

55 lambs, weight 4340 lbs., cost of marketing \$42.96, cost per head, \$ .78.

51 1-year wethers, weight 5540 lbs., cost of marketing \$54.84, cost per head, \$1.07.

53 2-year wethers, weight 6800 lbs., cost of marketing \$67.30, cost per head, \$1.27.

53 ewes, weight 5040 lbs., cost of marketing \$49.89, cost per head \$ .94.

Average cost per head, \$1.01.

The shipper will be safe in accepting the above data as regards cost of marketing, as in this instance, the expenses are a trifle normal. This is due to the necessity of holding over in St. for two and one-half days in order to complete the trip with a local stock train. In this case the expense of marketing was actually one cent per pound with the various classes.

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### Summary of Facts.

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8. The feeding of lambs for market is more profitable than for ewes or ewers, providing the ration is so adjusted as to give their maximum increase a finish.

9. Owing to the growthy tendency of the lamb, its ration must contain more fat producing material than the mature sheep.

10. Where grain is not available, the mature wether, though receiving a smaller proportionate increase, will fatten more readily than the lamb on clover or alfalfa alone. The use of from one-half to three quarters of a pound of grain, along with clover or alfalfa, throughout a period of from 70 to 90 days, is necessary to secure a proper finish for shipping.

11. For lambs, yearling and two year wethers and aged ewes, the following amounts of food were consumed per head, per day, 2.73 lbs., 4.45 lbs., 4.73 lbs., and 3.01 lbs. Attention is called to the fact that the amount consumed by the lambs is small, due to their low weights.

12. In order to secure an even finish, the grain fed formed the following percentages of the ration, viz: For lambs 24 per cent., for wethers 15 per cent, 2-year wethers 14 per cent., aged ewes 12 per cent.

13. The relative increase in live weight is represented in the following percentages: For lambs 37.7 per cent. 1-year wethers 25 per cent, 2-year wethers 20.9 per cent, ewes 17 per cent.

14. The following amounts of air dry food were required for maintenance and per pound increase, viz: Lambs 10.16 lbs., 1-year wethers 16.6 lbs., 2-year wethers 17 lbs. and ewes 17.5 lbs. As here-

tofore explained, this comparison applies properly to lamb ewes only, owing to difference in the proportionate make up wether rations.

(8). Relative costs of production per 100 lbs. increase: 1-year wethers \$4.18, 2-year wethers \$5.83, aged ewes \$6.90.

(9). Per capita cost of food consumed during 88 days: 1-year wethers \$1.37, 2-year wethers \$1.43, ewes \$1.05.

(10). Relative profits per capita from the four lots: 1-year wethers \$1.73, 2-year wethers \$1.40, aged ewes \$1.57.

(11). Percentage of dressed carcass after deducting 3 per cent from same: Lambs 54.2 per cent, 1-year wethers 52.9 per cent, 2-year wethers 53.6 per cent, ewes 50.6 per cent.

(12). Shrinkage in transit, covering 1400 miles, determined on weights while on full feed and those of sale: Lambs 8.7 per cent, 1-year wethers 8.7 per cent, 2-year wethers 8.5 per cent, ewes 8.5 per cent.

(13). The suggestion, resulting from personal experience, is offered to the effect that sheep will withstand shipping better on a limited allowance during transit, rather than on full feed, that feed and rest are essential toward the close of trip.

(14). The total net profit from the car of mixed sheep was \$251.29.

(15). Even though the cost of marketing is a large item, this is offset by cheap feeders and an abundance of cheap feed of good quality which renders the feeding business a profitable try.

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PART II.

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CATTLE FEEDING.

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The objects sought in this work were to determine the relative results from feeding light, medium and heavy grain rations in conjunction with legumes for fattening purposes. Though similar work has been done along these same lines in other portions of the country, still, it was thought best to repeat it here owing to the marked difference in the quality of Montana grown food stuffs. Figures were also sought to support previous assertions of the fact that only a minimum amount of grain is necessary along with our legumes to produce a good quality of beef or mutton.

For the purpose of this experiment twenty-two 2-year old steers were purchased by Mr. Jos. Kountz. These animals were grades showing Shorthorn blood and were growthy but thin and in a condition to put on flesh rapidly as the figures show. They were about the average of range production.

The feeding period was divided into three parts, viz: preliminary test and final. The preliminary period of twenty four days extending from Dec. 9th, 1901 to Jan. 3d, 1902, was necessary in order to get the animals all under full feed after the operation of dehorning. The trial test proper was a short one extending from Jan. 3d to Mar. 28th, a period of eighty five days. In the final the animals were merely kept on feed till April 12th when they were disposed of.

The feeding was done in open yards with sheds provided for shelter and with constant access to water. The sheds were used at night almost continually while in the case of the sheep very seldom. In general the weather was a little too mild during the test proper. The yards thawed out nearly every day. The best conditions seem to be when the thermometer does not rise above 32 degrees during the day.

### Food Consumed by Three Lots and Cost of Same.

#### LOT I. 7 STEERS.

Clover fed Jan. 2d to Mar. 28th, 11,540 lbs. at \$5 per ton.....	\$28.85
Barley meal fed Jan. 2d to Mar 28th, 2975 lbs. at 90c per cwt. ....	26.77
Total.....	\$55.62

#### LOT II. 7 STEERS.

Clover fed Jan. 2d to Mar. 28th, 11,560 lbs. at \$5 per ton.....	\$28.95
Barley meal fed Jan. 2d to Mar. 28th, 4008 lbs. at 90c per cwt. ....	36.07
Total.....	\$65.02

#### LOT III. 8 STEERS.

Clover fed Jan. 2d to Mar. 28th, 13,500 lbs. at \$5 per ton.....	\$33.75
Barley fed Jan. 2d to Mar. 28th, 6057 lbs. at 90c per cwt....	\$54.51
Total.....	\$88.26

The clover hay was fed twice each day in racks so constructed that there was no waste. The barley was ground and the meal fed in flat troughs raised about three feet above the ground.

### Average Amount of Food Consumed per Day.

Lot I. Clover consumed per head per day.....	19.3 lbs.
Lot I. Barley meal consumed per head, per day.....	5. lbs.
Total.....	24.3 lbs.
Lot II. Clover consumed per head per day.....	19.4 lbs.
Lot II. Barley meal consumed per head per day.....	6.73 lbs.
Total.....	26.13 lbs.
Lot III. Clover consumed per head per day.....	19.8 lbs.
Lot III. Barley meal consumed per head per day.....	8.9 lbs.
Total.....	28.7 lbs.

Attention is called to the fact that the amounts of clover consumed daily are about the same for the three lots, even though the amount of grain increased from lot I. up. The fact that more food

was required even where more grain was fed is due to the greater weights of lots II. and III. The division was made on a basis of quality rather than weight. The aim being to have the steers of the different lots as even in quality as possible.

### Preliminary Weights and Effect of Dehorning.

22 steers, weight Dec. 9th, 1901, 22185 lbs., average 1008.

22 steers, weight Jan. 2d, 1902, 23170 lbs., average 1053.

Average gain during period of twenty four days 45 lbs.

Gain per head per day during period of 24 days, 1.87 lbs.

Gain per head per day during period of 85 days, 2.27 lbs.

The figures relating to weights secured during the preliminary period show that dehorning had little effect on the steers. The average daily gains are some smaller, which is partly due to the fact that less grain was fed than in the next period. These animals fed heartily immediately after the operation.

### Test Weights, for 85 Day Period.

VARIOUS LOTS.	Weight Jan. 2d, 1902.	Average.....	Weight Mar. 26, 1902.	Average.....	Total Increase.....	Increase per head.....	Increase per day.....	Per cent Increase.....
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Per ct.
Lot I, 7 Steers ..	6850	978.5	8240	1177	1390	198.5	2.33	20.2
Lot II, 7 Steers...	7240	1034.3	8590	1227	1350	192.8	2.26	18.6
Lot III, 8 Steers..	9080	1135.	10600	1325	1520	190.	2.23	16.7

### Food Per Head Per Day per 100 lbs. Live Weight.

Pen I. Average 1077 lbs. barley per cwt. .46 lbs. clover 1.79 lbs.

Pen II. Average 1130 lbs. barley per cwt. .59 lbs. clover 1.71 lbs.

Pen III. Average 1230 lbs. barley per cwt. .72 lbs. clover 1.61 lbs.

The results indicate that where legumes are used as roughage, not more than one-half pound of meal per 100 lbs. live weight, per day, is necessary to produce satisfactory gains and at the smallest cost. This is true only, however, of perfectly cured and preserved clover and alfalfa, such as are produced in the arid west.

#### **Solid Food per lb. Increase.**

Lot. I. Food per pound increase, 10.4 lbs.

Lot. II. Food per pound increase, 11.5 lbs.

Lot. III. Food per pound increase, 12.9 lbs.

Attention is called to the fact that these figures include maintenance during the time each pound was being produced and that owing to differences in live weight these figures would be affected accordingly.

#### **Cost Per Pound Increase.**

Pen No. I. Cost per cwt. increase, \$4.00

Pen No. II. Cost per cwt. increase, \$4.81

Pen No. III. Cost per cwt. increase, \$5.80

#### **Financial Statement.**

Jan. 2d, 1902—By clover, first period, 14,295 lbs. at \$5 per ton..	\$ 35.73
Jan. 2d, 1902—By barley, first period, 1141 lbs. at 90c cwt....	10.26
Mar. 28, 1902—By clover, test period, 36,600 lbs. at \$5 per ton.	91.50
Mar. 28, 1902—By barley, test period, 13,040 lbs. at 90c cwt....	117.35
Apr. 12, 1902—By clover, third period, 6435 lbs. at \$5 per ton..	16.08
Apr. 12, 1902—By barley, third period, 2267 lbs. at 90c cwt....	20.4
Dec. 9, 1901—By 20 steers, at \$33.00 per head.....	660.00
Dec. 9, 1901—By 2 steers, at \$34.00 per head.....	68.00
Apr. 15, 1902—By net profit on 22 steers.....	168.68
	<b>\$1188.00</b>
Apr. 15, 1902, To 22 steers at \$54.00 per head.....	\$1188.00
Net profit per head.....	<b>\$7.66</b>

This sum does not represent the complete profit from each animal as the food is charged up at local market prices and is much above cost.

The carload of steers was purchased by Mr. Jno. Kiefer of Bozeman, by whom the carcasses shown in the illustrations were prepared for photographing.

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### Conclusions.

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(1). Because of the quality of Montana grown food products and the favorable climatic conditions during the winter feeding period, maximum returns can be secured from a minimum amount of food.

(2). That in fattening steers, when alfalfa and clover are used, not more than one-half pound of grain to the hundred weight of live weight is necessary to produce the most satisfactory results.

(3). Contrary to local impressions, some grain must be used throughout a period not less than one hundred and twenty days in order to get a good finish.

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### Acknowledgments.

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The report of slaughter test so kindly furnished by the Messrs. Swift & Co. of Chicago has been of great service, not only because of the information furnished by it, but also from additional data which could only be secured through its aid.

Much of the success of this work is due Mr. G. M. Fuller under whose supervision the experiments were conducted.



BULLETIN NO. 36.

MONTANA AGRICULTURAL

# Experiment Station,

OF THE

**Agricultural College of Montana.**

## FORAGE CONDITIONS

OF CENTRAL MONTANA.

**Bozeman, Montana, June, 1902.**

REPUBLICAN.  
Bozeman, Montana,  
1902.

# MONTANA AGRICULTURAL EXPERIMENT STATION

BOZEMAN, - MONTANA.

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All communications for the Experiment Station should be addressed to the  
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MONTANA EXPERIMENT STATION.

Bozeman, Montana.

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NOTICE.—The Bulletins of the Station will be mailed free to any citizen of  
Montana who sends his name and address to the Station for that purpose.

# Montana Experiment Station.

BULLETIN NO. 36.

JUNE, 1902.

FORTIER,

Director Montana Agricultural Experiment Station.

DEAR SIR:

The accompanying paper on the "Forage Conditions of Central Montana" is the result of investigations made for the Station by Mr. Frank A. Spragg during 1900 and 1901, under the direction of the botanical department of the Montana College of Agriculture and presented as his thesis on graduation from the Agricultural Course.

The field-work was done in Fergus county and the region immediately adjacent, during which nearly a thousand specimens were collected for the Station and many interesting facts regarding existing forage conditions in this region have been noted. These studies cover a large portion of the state not readily accessible from the railroad and hence not previously studied by botanists, although one of the most important sections in its stock-growing interests.

Already the ranges in many parts of the state are showing signs of exhaustion and the number of stock supported upon a given acreage is rapidly diminishing, while the recent tendency of the stockmen to purchase or lease these ranges for private use, tends to make questions of their improvement and rendering them more productive of increasing importance. But before any systematic attempt can be made, it is necessary to determine the results of close-pasture upon the ranges, the conditions formerly existing and those now found, as well as the various species of grasses, which form the component parts of these ranges, those found most hardy under pasture and the most drought resisting in dry seasons with their relative value for hay and pasture. It is with these preliminary studies of the region in question that Mr. Spragg deals and his paper appears to be of sufficient importance to warrant its publication as a bulletin of this Station.

Mr. Spragg has also added a synopsis of all the genera of grasses found in the state by which beginners in this difficult order will be able

to work with more certainty in the determination of the different groups than with any of the schemes now available. It may be well to state that the collections upon which these notes are based have been compared by Mr. Spragg with specimens in our Station Herbarum, named by Dr. F. L. Scribner, while the more difficult species have been sent to the Division of Agrostology at Washington for determination.

R. S. SHAW, Agriculturist.

J. W. BLANKINSHIP, Botanist.

Bozeman, Montana, June 14, 1902.

## **FORAGE CONDITIONS OF CENTRAL MONTANA.**

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BY FRANK A. SPRAGG.

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### **Geology and Physiography of the Region.**

The portion of the country lying between the Missouri, Smith and Musselshell rivers is traversed by the Little Belt, Big Snowy, Judith, and Highwood mountains. It includes a great variety of conditions and fosters many industries, of which stock-raising is the principal, and large numbers of fat cattle and sheep are yearly shipped to eastern markets. Large quantities of wool are sold in the markets of Billings and Great Falls, or shipped east, and lately there has been a good demand for horses. The mountains are celebrated for mines of gold, silver and sapphires, and at their base are found limestone, gypsum and coal. Montana also has a belt of artesian water, due to the following conditions: running across the country, we have the outcrop of the coal seam of the Cascade geologic formation; this line of exposure crosses Sun river near the foot of the Rocky Mountains, and, swinging eastward, follows near the north edge of the Little Belt mountains, several miles south of Great Falls. At Sand Coulee and at Belt it presents vast workable seams of coal; continuing eastward, it follows Aster creek some fifteen miles, and crosses Arrow creek near its head; then crosses Wolf creek four miles above Stanford, and the Judith river at Utica; running thence north of the Snowy mountains, it passes above Lewistown and around the west, north and east foot of the Judith mountains. Along this line of exposure are numerous coal mines furnishing the country with its total supply. This outcrop is

but the edge of one of many layers lapping against the mountain. Some of these layers are composed of clay and will not allow water pass through; others are so loose and porous that large quantities of water disappear yearly along the foot of the mountains above the coal seam. A remarkable example of this is Dry Wolf creek, southwest of Stanford. Up in the mountains there is a swift stream about a rod in width in a bed of clay and gravel; at the mouth of the canyon the stream reaches the edge of a mass of loose, broken limestone; within two miles the entire stream has disappeared, and from there to its mouth, except in time of melting snow, the stream bed is but a mass of loose, dry gravel. Along the Snowies, and particularly around the Judith mountains, the larger portion of the water falling as rain and snow sinks in this way. Where does all this water go? Again, where are the Giant springs at Great Falls, and Big and Warm Springs on the east side of the Judith basin, if they do not have artesian sources? It is very noticeable, as one examines these springs, that the rocks around appear to have been shaken apart. One will notice a dark opening here and there with long strings of vegetation floating over, and a short distance down stream a big roll in the water may be noticed, showing that large quantities of water are flowing out.

Within a year previous to September 1, 1901, some half dozen artesian wells had been bored in the west side of the Judith basin and just below the outcrop of the coal. At Utica the water is spouting about eighteen inches above the opening of a three-inch pipe. Another company was boring a six-inch hole at Mr. B. E. Stack's ranch on Willow creek Sept. 4; they were then down 165 feet; they struck about ten barrels an hour at 257 feet, and bored to 317 feet. A good flow is expected at 500 feet, where they expect to finish the well. It is said that water was struck at Utica at 200 feet, though the well is now 800 feet deep, and on Sage creek at 80 feet, though the well is 393 feet deep. There is no reason why artesian water could not be found anywhere in the open country below the line of coal, there is but one difficulty presented. The amount of material piled on the top of the coal increases rapidly as one goes away from the mountains; on the Benton stage road at Arrow creek, this mass is probably 1,500 feet thick, and at the mouth of the Judith at least

500 feet. The greatest depth the machine could bore, which was at r. B. E. Stack's Sept 4, was 800 feet.

The soil in the mountain parks is usually deep, mellow and rich, belonging to the Cambrian formation. Around the foot of the mountains, as has been seen, we have a belt of loose limestone. The soil is stony and useful mainly for pasture. Further out we have stretches of nearly level bench lands. Portions are covered with gravel, sand, and alluvium, and only clay enough to convert the whole into productive soils. This mass has been left in passing ages by streams as they shifted from place to place over this comparatively level country. The benches of the northern portion of this district are covered with clay, and, polished pebbles, and some boulders. This glacial drift was left when the northern transcontinental ice sheet melted away. As a rule this drift contains less plant food than the bench gravels. Along the Missouri river, we find sharp gorges which have been cut in recent times through the bench gravels or glacial drift, exposing the clays of the Cretaceous below. These steep hillsides, sandy points, and stretches of worthless clays make up the badlands. These badlands are low in plant food, rich in alkali, and next to worthless for cultivation. However, in the larger bottoms along the Missouri, crops of wheat, grain and vegetables are often raised.

### The Natural Plant Formations.

The grasses of Central Montana may be grouped, depending upon soil, moisture and situation, into six different, though intergrading, plant formations. These are: The Badlands, Alkali Flats, Prairie benches, Wet Meadows, Foot-hills and Mountain Parks.

In the **Badlands** where the hills are rounded or flat-topped, we are apt to find the regular bench flora; but on the true side hill of this region, we find a scattering flora of salt-grass (*DISTICHLIS SPICATA*), blue-grass (*KOeleria cristata*), feather-grass (*STIPA VIRIDULA*), and here and there a bunch of blue-joint, (*AGROPYRON OCCIDENTALE*), on the better soil. On sandy points, putting down from the main hill, we find sand rush-grass (*SPOROBOLUS CRYPTANDRUS*), prairie rush-grass (*SPOROBOLUS BREVIFOLIUS*), and Indian millet (*ERICOMA CUSPIDATA*)

usually. In little bottoms and ridges between the main hill and the flats below, made up principally of sandy drift from the hillside, some of which most of the alkali has been washed, may be found a rich sod of blue grama (*BOUTELOUA OLIGOSTACHYA*). The two little persistent slender fescue (*FESTUCA OCTOFLORA*), and little barley (*HORDEUM PUSILLUM*), are often found here in clusters mixed with the blue grama.

The **Alkali Flats**, though often occurring in the Badlands, are commonly found in the open country. They are places where alkali water collects and evaporates. Portions of the great sag south of Belton are two hundred feet below the surrounding country. It contains six large lakes and several small ones; the larger ones are surrounded by bare alkali coated flats. White, dry patches are to be found in little sags quite generally over the country. As we recede from the barren patch, we first find salt-grass (*DISTICHLIS SPICATA*), and then the degrees June grass (*KOELERIA CRISTATA*), and smooth bunch grass (*POLYPOGON LAEVIGATA*). Depending upon conditions, we may also find rough leaved salt-grass (*SPOROBOLUS ASPERIFOLIUS*), alkali meadow grass (*PUCCINELLIA AIROIDES*), and squirrel-tail grass (*HORDEUM JUBATUM*). In the non-alkaline soil on the edge of alkali places blue joint and blue grama are apt to be found, but these grasses can withstand but small quantities of alkali.

The **Prairie Benches** stretch from the Badlands and alkali flats to the foothills of the mountains. They are the drier upland portions of the country, crossed by creek bottoms and dotted by wet meadows. The grasses of which belong to a distinct flora, and are used principally for pasture. The principal grasses of the benches are blue grama (*BOUTELOUA OLIGOSTACHYA*), and blue joint (*AGROPYRON ODONTALE*). Prairie June grass (*KOELERIA CRISTATA*), needle grass (*STIPA COMATA*), bunch wheat grass (*AGROPYRON DIVERGENS*), and two or three meadow grasses (*POAS*) are also found more or less scattered. Around intermittent pond holes are found hair grasses (*AGROSTIS HELMIS*) and squirrel-tail grass, and floating foxtail mixed with two or three sedges in the bottom.

It has been mentioned that the meadow grasses grow very scattered on these benches to-day, and belong in large part to what was once

**TENUIFOLIA.** Prof. F. L. Scribner, who saw the country in the summer of 1883 says, "Poa tenuifolia may be regarded as the grass of the country. No species withstands the long summer drought so well, it constitutes the chief forage upon the dry bench lands." As grass is almost exterminated to-day, it is evident that it cannot endure over-stocking. A rancher who came to the country shortly after 1880, describes the grasses of these benches then as a thick mat of leaves shading the ground and growing to a height of six or eight inches. He says further that this mass of leaves was inclined toward the southeast by the northwest winds. He did not know the name of the grass, but his description would lead me to call it blue-grama. To-day the blue grama (*Bouteloua*) is the most abundant as a grass of curly leaves covering the ground but two or three inches at best. It is probable that in former times, before the ranges were over-stocked, that the meadow grasses (*Poas*), blue joint and other cool-season grasses, and the prairie June grass, formed the greater part of the forage, and that the blue grama grew much ranker than it does now. In those favored times, some old timers say they could ride across the country with their feet dragging in the grass. The grass would fall to the ground each fall, and was in time transformed into a mat, which thickened year by year and protected the ground from the hot sun. Large quantities of moisture thus retained enabled the grasses to grow exceedingly rank. Perhaps none of the above named grasses have been exterminated for the lack of moisture, but on account of too close feeding, and the tramping of stock they have been so reduced in quantity as to be almost absent in some places. The blue grama, being the last of the grasses to succumb to the over-stocking process, has taken possession of the soil as the other grasses have disappeared. The difference, then, between the over-stocked range of to-day, and the luxuriant growths of former times is to be found simply in the relative abundance of the blue grama.

These prairie benches have proven themselves to be among the best soils of the country. They are similar to those along the north slope of the mountains, which will be considered under the head of foothills. The principal distinction is a slight difference in moisture depending upon the amount of moisture present, the foliage of these

benches today, ranges from a thick mass of blue-joint leaves on down through all the gradations of the grama soil to where even this valuable grass has succumbed to a "moss" (*Selaginella rupestris*, Spring) and desert conditions prevail.

The **Wet Meadows**, though characterized by at most totally different flora, grades into the surrounding formations. The grasses present vary somewhat with conditions of soil and moisture, and depend largely upon the presence or absence of alkali. When water stands on the surface, we usually find rushes and sedges, or slough grass (*BECKMANNIA ERUCAEFORMIS*), and reed meadow grass (*PANICULARIA AMERICANA*), in small quantity. If the soil is wet, but not covered with water, prairie rush grass (*SPOROBOLUS BREVIFOLIUS*), alkali meadow grass (*Puccinellia airoides*), early bunch grass (*Eatonobtusata*), tussock grass (*Deschampsia cespitosa*), cord grass (*Spartocynosuroides*), foul meadow grass (*Panicularia nervata*), and pale bunch grass grow in varying proportions. Or, in addition to the above, if alkali is absent, reed canary grass (*Phalaris arundinacea*), along the banks of running streams. If alkali is present in small quantity and the soil is not very wet, rough-leaved salt-grass (*Sporobolus asperifolius*), and especially prairie rush grass (*Sporobolus brevifolius*), are to be found in large quantity. If the alkali is very strong all the above named grasses may be killed out and only salt-grass remain.

The region considered as **Foothills** here is not necessarily a strip extending out in all directions from the base of the mountains. We are considering the character of a certain group of grasses that may be regarded as belonging to the foothill flora. The prairie bench formation seems to extend to the foot of the mountains on the south side of the smaller mountain ranges of the plains, while on the north side of the same ranges are semi-circular areas, the flora of which does not resemble that of either the prairie-bench or the mountain park formations. The soil, as has been said, is similar to that of the dry benches but receives more moisture. The strip north of the Little Belt mountains is wide to connect them with the Highwoods along the divide between the Arrow Creek and Belt Creek basins. The foothills are today dotted by thrifty crops and meadows. A few years ago this foothill country was used only for pasture, as the dry

grasses are today. On the upland benches the sheep-fescue (*Festuca elatior*), and red fescue (*Festuca rubra*) take the place of the blue grama of the prairie. In nooks partly sheltered by the mountains, blue-grass (*Festuca campestris*) is the principal forage. A large number of grasses are to be found here. The hays are mainly the cultivated and mountain timothy; *Bromus inermis* is only just coming into cultivation. There are several native grasses that no doubt would do well under cultivation, among which are the wheat and brome grasses, and on wet land the reed canary grass.

Grasses are also coming in on the mountain side where the timber has been burned off and the soil is not too stony. The principal of these are the western brome (*Bromus Pumpellianus*), pale bunch grass (*Poa alpina*), wood meadow grass (*Poa nemoralis*), downy oat-grass (*Trisetum flavescens*), timothy (*Phleum pratensis*), and four wheat grasses (*Agropyron*).

About forty different varieties of grasses are found in the Mountain Parks of Central Montana between the altitudes of 5000 and 7000 feet. The loose deep rich soil is literally filled with the roots of plants that probably bloom each and every month during the summer.

The quantity of native forage is usually no greater than in the foothills and many of the grasses are similar. The hay grown here is mainly timothy or oat-hay. Under native conditions the land is often too rough to cut wild hay. It is said that clover and alfalfa will not grow well. There are some of the native grasses that are certainly worthy of cultivation and some of these may be found superior to any of the tame varieties for cultivation at high altitudes and in mountain parks. Among them are mountain timothy (*Phleum alpinum*), mountain fox-tail (*Alopecurus occidentalis*), mountain rye grass (*Elymus glaucus*), slender wheat grass (*Agropyron tenerum*), western brome grass (*Bromus Pumpellianus*), and snow-grass (*Festuca campestris*).

### Economic Considerations.

There are still many problems to be considered that relate either directly or indirectly to the forage conditions of this region. Notably among these are the water supply, and its most economic use as well as

the improvement of the ranges. Large quantities of water go to waste one way and another. A few snowbanks remain in the mountains to supply water for irrigation, but most of the water runs off during spring break-up to deluge the people along the lower Mississippi. Why should not a portion of this be saved in reservoirs for irrigation and to water stock later in the summer? The government has surveyed over thirty reservoir sites, mainly in Central Montana. It may be that the artesian supply will also become important. The amount of water needed to benefit a given meadow should be more carefully studied. Blue joint is universally regarded as the richest hay of the country, and by careful irrigation our native uplands will yield good stands; yet when water stands on the surface this grass disappears and is replaced by rushes, sedges and the less valuable grasses of the meadow flora. It must be borne in mind that our most valuable grasses do not grow in swamps. Most of them are easily drowned and replaced by others less valuable. "Under the present conditions one may frequently see a man injuring his meadows and fields by using too much water, while those of his neighbor some miles down the valley are suffering, perhaps totally ruined, for lack of the water."

When the pioneer came west he found the ranges covered with vast forage resources. The question then was, how can we get stock enough to use this wealth? Now conditions have changed. There is more stock on our ranges than they can support. Each rancher "knows" that if his stock does not eat the grass, that of somebody else will. Naturally he thinks he might as well benefit by it as anyone. In his effort to get his 'share' he contributes to the general destruction instead of trying to avert it."

As conditions are drifting now, it is only a matter of time when the public domain will be owned or leased by the ranchers. If the price can be made reasonable so as not to exterminate the smaller owners they will be given an incentive to adopt measures for the betterment of their holdings, and knowing that they and not someone else will receive the benefit of their endeavors, they will make the subject a study year by year their ranges will be enabled to support more and more stock. It has been asserted that all the ranges need is rest, but it has been pointed out, in speaking of the blue grama, that conditions have come where the most valuable of our range grasses have been nearly exterminated. The reseedling of the ranges is a problem that each rancher must study for himself.

**Generic Key to the Grasses and Grass-like Plants of Montana.**

Note.—In the following scheme the word “glume” signifies the outer empty scales; “pale” denotes the inner scale enclosing the flower; and “spike” is used to indicate any dense cylindrical inflorescence. Number before name indicates paragraph.

- Perianth of six glumaceous segments; capsule 3-valved.....A.  
 Perianth of bristles, minute or none:  
     Flowers in the axil of single glumes; stems solid; sheaths closed ..... B.  
     Flowers enclosed in a pair of glumes; stems hollow; sheaths split..... C.

**A. Juncaceæ (RUSH FAMILY).**

- Leaf-sheaths open; capsule 1-3 celled, many seeded; placenta parietal or axial.  
     Plants never hairy; on moist ground..... JUNCUS.  
 Leaf-sheaths closed; capsule 1-celled, 3-seeded; placenta basal. Plants usually  
     hairy; often on dry ground..... JUNCOIDES.

**B. Cyperaceæ (SEDGE FAMILY).**

1. Flowers perfect; spikelets all similar ..... 2  
 1. Flowers monœcious or diœcious, usually borne in separate spikelets.. CAREX.  
 2. Spikes in single or umbelled terminal heads; spikelets 2-rowed.... CYPERUS.  
 2. Glumes spirally imbricate all around..... 3  
 3. Base of style swollen, persistent as a tubercle on the achene; spikes  
     solitary..... ELEOCHARIS.  
 3. Base of style narrow, deciduous..... 4  
 4. Spikes one to many; bristles 1-6 included, rarely none..... SCIRPUS.  
 4. Spikes few; bristles 6-many, soft, very long, slender, and much exerted.  
     ..... ERIOPHORUM.

**C. Gramineæ (GRASS FAMILY).**

- Inflorescence spicate..... 2  
 Inflorescence, a raceme of unilateral spikes; spikelets 2-rowed..... 20  
 Inflorescence, a compound raceme of panicle spikelets..... 21  
 Inflorescence, of paniculate unilateral spikes ..... 19  
 Inflorescence, an open panicle ..... 23  
 2. Spikes equilateral, cylindrical to capitate..... 3  
 2. Spikes unilateral..... 4  
 3. A strictly cylindrical spike; spikelets one-flowered, close, and equally distributed on axis ..... 5  
 3. Spikes short, ovate to capitate ..... 6  
 4. Unilateral spikes, paniculate, often loose..... 19  
 4. Unilateral spikes racemose..... 20

5. Glumes united at base, awnless; pale one, awned..... 12-13, ALOPECUR
5. Glumes distinct, mucronate; pales two, awnless..... 59, 59, PHELEU
6. Spikelets unisexual and dissimilar; staminate and pistillate on the same  
or separate plants..... BULBI
6. Spikelets with one perfect flower and often another imperfect.....
6. Spikelets with two to many perfect flowers.....
7. Three spikelets at each joint of articulate rachis..... 49-50, HORDEU
7. Spikelets not all alike, usually in twos; axis of spikes or racemes hairy; fer-  
tile glumes awned..... 14, ANDROPOG
7. A large, short spike or a panicle of these; spikelets but one at a place, not  
clustered, awnless..... 57, PHALAI
7. Flowers perfect, single.....
8. Pale awned or sharp pointed.....
8. Pale awnless, shorter and broader than the glumes.....
9. Pale awn terminal or absent; pales firmer than glumes and closely envelop-  
ing the grain.....
9. Pale awn dorsal; grain loose or not at all enclosed.....
10. Tuft of long silky hairs at base of pale..... 24-29, CALAMAGROS
10. Pale not hairy..... 9-11, AGROS
11. Pale sharp pointed to long slender awned..... 54, MUHLENBERG
11. Pale with long, stout, twisted awn..... 72-75, STI
12. More or less paniculate, spikelets not sessile.....
12. Spikelets sessile on alternate notches of the rachis.....
13. Pale obtuse or with short terminal awn.....
13. Pale awn dorsal, twisted and bent:
  - (a) Spikelets 9-16 mm. long..... 32-34, DANTHON
  - (b) Spikelets 4-7 mm. long..... 76, TRISET
14. Pale sharp pointed; spikelets in very short clusters mixed with leaves  
..... MUNR
14. Pale obtuse or acutish; first glume narrowly linear, second glume broadly  
obovate..... 37, EATON
14. Pale and glume both acute and about the same length..... 52, KOELE
14. Pale usually awned at tip; flowers distinct..... 44-47, FESTU
15. Spikelets solitary at each joint of the rachis.....
15. Spikelets two, rarely as high as six, at each joint of rachis.....
16. Cultivated grasses (wheat and rye); pale sometimes keeled.....
16. Native grasses; pale round on back..... 1-8, AGROPYR
17. Nerves of pale convergent at tip; glumes 1-nerved..... SECA
17. Pale nerves parallel; glumes 3-many nerved. (Wheat)..... TRITIC
18. Rachis not articulate; glumes entire..... 38-42, ELYM
18. Rachis articulate; glumes two or more parted..... 67, SITANI
19. Spikelets one to two flowered, subsessile on two sides of a subtriangular  
rachis in a long narrow panicle..... 17, BECKMAN
19. Spikelets many-flowered, much flattened, subsessile, and densely crowded  
in thick one-sided clustered..... DACTY

ikelets crowded in two rows on one side of rachis. Prolongation of rachilla triaristate.....	18, BOUTELOUA.
ikelets flattened, subsessile and strongly compressed on two sides of a triangular rachis.....	68, SPARTINA.
ikelets obtuse, often short-pedicelled, and scattered; first glume usually shorter than the second....	PANICUM.
e perfect sessile flower alternating on two sides of a slender three-sided rachis .....	66, SCHEDONNARDUS.
o to many perfect-flowered, pedicelled spikelets.....	22
umes one to two nerved; pales 3-nerved .....	ERAGROSTIS.
umes 3-9 nerved; pales 5-many nerved.....	53, MELICA.
ikelets with one perfect flower and often another imperfect .....	24
ikelets with two to many perfect flowers .....	31
ikelets usually in twos, not all alike; axis of spikes or raceme hairy; fertile glumes awned .....	14, ANDROPOGON.
ikelets not more than one in a place:	
(a) Containing no abortive flowers.....	25
(b) With abortive flowers; first glume shorter, awnless.....	PANICUM.
le firmer than glume and closely enveloping the grain.....	26
le usually thin, not as firm as glume; grain loose or not at all enclosed .	28
le entire bearing a terminal three-branched awn.....	15, ARISTIDA.
le awn terminal or between two teeth, simple.....	27
le sharp pointed to long slender awned.....	54, MUHLENBERGIA.
le tipped with a long, stout, twisted awn .....	72-75, STIPA.
ret globular, clothed with long, silky hairs.....	43, ERIOCOMA.
chilla usually bearing a tuft of long silky hairs produced beyond it;	
pale membranous .....	24-29, CALAMAGROSTIS.
chilla usually bearing a tuft of long silky hairs at base of pale. Tough	
sand-binding grasses.....	30, CALAMOVILFA.
se of pale naked or thinly barbed.....	29
le sessile in glumes .....	30
le stalked in glumes, awned on back .....	CINNA.
le acute, awnless; glumes two, shorter than pales; spikelets sometimes	
two-flowered.....	69-71, SPOROBOLUS.
le obtuse, often awned on back; glumes two, longer than pales.....	
.....	9-11, AGROSTIS.
le obtuse, keel often extending into a short awn; glumes four, longer	
than or as long as pales.....	SAVASTANA.
le-awn dorsal or between two lobes at apex, more or less twisted and	
bent.....	32
le awnless or with a terminal straight awn; glumes shorter than pales..	35
le-awn between two teeth or lobes, twisted and bent; spikelets 9-16 mm.	
long.....	32-34, DANTHONIA
le-awn dorsal or basal .....	33.

33. Spikelets less than 10 mm. long.....
33. Spikelets more than 10 mm. long..... 16, AV
34. Pale obtuse; awn taper-pointed, not articulate..... 35, DESCHAM
34. Pale 2-toothed; one or two of uppermost florets awned..... 76, TRISE
35. Tall reed-like grasses; long hairs on rachilla..... PHRAGM
35. Not reed-like; pale naked or with hairs shorter than glumes.....
36. Pale 1-3 nerved.....
36. Pale 3-many nerved; spikelets 2-8 flowered, 5-20 mm. long; first glume 3-nerved, second 5-7 nerved..... 53, MEL
36. Pale 5-many nerved.....
37. Glumes nearly equal in length but very unlike, the first narrowly linear the second broadly obovate, obtuse..... 37, EATO
37. Glumes unequal in length but similar in shape.....
38. Spikelets 2 rarely 3-4 flowered; 2-4 mm. long..... CATABR
33. Spikelets many flowered 2-18 mm. long..... ERAGROS
39. Spikelets 6-8 mm. long, densely crowded in thick one-sided clusters. (Cultivated)..... DACTY
39. Rays in whorls of 1-5 or more; glumes awnless.....
40. Lateral nerves of pale nearly parallel, not converging; glumes shorter than pales. Moist meadows usually.....
40. Lateral nerves of pale arched and converging above.....
41. Glumes nerveless or 3-5 nerved; pales with 3-9 conspicuous nerves; spikelets 2 mm. broad, and 3-15 mm. long..... 55-56, PANICULA
41. Glumes 1-3 nerved; pale obscurely 5-nerved; spikelets 2 mm. wide and 3-15 mm. long..... 65, PUCCINEL
42. Rachilla fringed with downy, cobweb-like hairs around the pale; pale usually obtuse awnless; spikelets 3-10 mm. long..... 60-64, L
42. Spikelets 5-13 mm. long and not crowded on the naked rachilla; pale round on back, sometimes keeled and often awned..... 44-47, FESTU
42. Spikelets 10-40 mm. long; rachilla naked; pale often awned.. 19-21, BROM

**Annotated List of the Grasses of Central Montana.**

**1. *Agropyron occidentale*, Scribn. Blue-Joint or Blue Stem. [Fig 1].**

This grass, popularly known as blue-joint, grows on mixed soils of clay, sand and gravel and is found widely scattered from the edges of heavily alkaline soils through the upland prairie benches and foot-



hills to the mountain parks. Growing alone, it often forms a thick rank mass of foliage on rich black loam meadows which are overflowed by water periodically. Under these conditions it forms the very richest and best hay of the country. Where water stands on the surface in summer, it kills out easily and in its place come rushes, sedges and the grasses of the wet meadow flora. Where over-irrigated, alkali, too, is apt to come in, and grasses, like salt grass, which can better endure alkali, take the place of the blue joint. Its scattered growth seldom heads out on the prairie benches today. It is easily killed out by the close grazing and tramping of stock.

1. *AGROPYRON OCCIDENTALE*, Scribn.  
(U. S. Div. of Agros.)

**2. *Agropyron occidentale molle*,  
Scribn. Colorado Blue-stem.**

**3. *Agropyron divergens*, Nees. Bunch Wheat Grass.**

On the prairie benches this forms bunches often a foot in diameter and one to two feet high. Clustered near the edge of steep slopes, they are often, at a distance, mistaken for sheep by strangers. In the foothills it blends with other grasses to form valuable range meadows. Growing alone, it often covers south exposures. When cut yearly, it makes good hay for horses and cattle, but is rather coarse for sheep.

4. *Agropyron Gmelinii*, S. & S. Short-leaved wheat grass.

5. *Agropyron pseudorepens*, S. & S. False quack grass.

These resemble blue-joint in many of its habits and are popularly confused with it, but are rather rare.

6. *Agropyron Richardsoni*, Schrad. Bearded wheat grass.

This grass grows in moist meadows, in the foothills and in mountain canyons and parks. It appears to intergrade with *Elymus glaucus*.

7. *Agropyron tenerum*, Vasey. Slender wheat grass.



2. *Agrostis alba*, L.  
(U. S. Div. of Agros.)

In the prairie portion of the country, it is sometimes found in ravines and meadows, but often in thickets of rose and buck brush. It makes as good or better hay than timothy, and is sometimes found alone or mixed with a few other rank grasses in creek bends of the foothills.

8. *Agropyron violaceum*, Lange.  
Mountain wheat grass.

This grass is found high on mountain sides, in mountain parks and in the upper edge of the foothills. It seldom grows alone, but adds its value to the general grass flora.

9. *Agrostis alba*, L. Red Top [FIG 2]

This tame grass is to be found to-day in many parts of the country. A few years ago large quantities of the seed were shipped in and sold out to the ranchers of two or three localities. They were looking for a drought-resisting grass, and as this received high commendation by the store-keepers

y sowed it on land where other grasses had failed to give a good crop. The resulting failure caused many people to condemn it; it has been found to make rank growth of hay on land that is wet for most other grasses—land usually covered by rushes and sedges. However, the land must not be submerged. If those who have drowned out their blue-joint meadows would sow red-top before rushes and sedges come in, they may still expect good hay. If the rushes and sedges have taken possession, it may be necessary to plow the land before the red-top will catch.

0. *Agrostis asperifolia*, Trin. Rough-leaved bent-grass.

This grass, though resembling red-top in many ways, grows on much dryer land and to greater altitudes, but will not furnish as large a quantity of hay. With other grasses, it sometimes forms a large portion of the vegetation in certain mountain meadows.

1. *Agrostis hiemalis*, B. S. P. Hair grass, or tickle grass.

Widely scattered from the alkaline flats of the Badlands almost to the mountain tops, this grass grows around the edge of intermittent pond holes mixed with what is popularly known as foxtail (*HORDEUM GLABRUM*). In some respects it resembles red-top and is often found mixed with it, but is almost worthless for hay.

2. *Alopecurus geniculatus*, L. Floating foxtail.

Mixed with two or three small sedges, this grass covers the bottom of intermittent pond holes and portions of river flood-plains, as the low bank of the Missouri above Great Falls. It sometimes grows to a height of a foot or more, but falls easily.

13. *Alopecurus occidentalis*, Scribn. Mountain Foxtail. [Fig 3.]

Though this grass was found by the writer only in the upper of Belt Park under the shade of small clumps of white pine, it is reported at high altitudes throughout the Rocky Mountain region. In alpine meadows it often makes a remarkably luxuriant growth, frequently reaching a height of three or four feet. Its foliage is soft, but it is probably one of the most promising of the native grasses for cultivation in meadows at the higher altitudes and in moist partly shaded mountain parks.

14. *Andropogon scoparius*,  
Mx. Little Blue Stem.

Grows in clumps a foot or two high on steep gravelly side-hills and in the bottoms of rocky ravines of the drier portion of the country. It heads out late in August and is tough and woody, not usually eaten by stock.

15. *Aristida longiseta robusta*, Merrill. Dogtown grass.

Its habits are very similar to those of *Andropogon scoparius*.



3. *ALOPECURUS OCCIDENTALIS*, Scribn.  
(U. S. Div. of Agros.)

16. *Avena Americana*, Scribn. American oat-grass [Fig. 4].

This is found principally on the upland benches of the foothills and the dryer portions of the mountain parks, but it is also seen in mountain canyons and in sheltered ravines of the plains. It grows from a few inches to a foot high. Mixed with other grasses, it adds greatly to the value of the forage, but will never form a meadow by itself.



4. *Avena Americana*, Scribn.  
(U. S. Div. of Agros.)

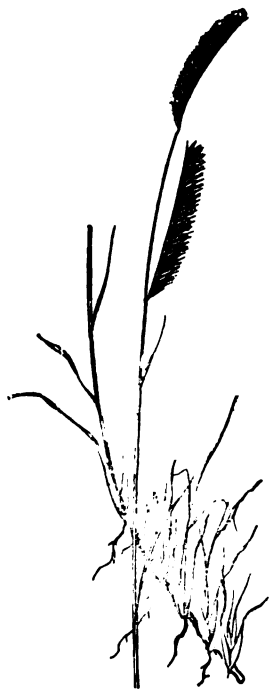
17. *Beckmannia erucæformis*, Host. Slough Grass. [Fig. 5].

5. *Beckmannia erucæformis*, Host.  
(U. S. Div. of Agros.)

The name slough grass is popularly confused with a collection of broad-leaved sedges, not grasses at all. This grass grows in shallow water with rushes and sedges.

18. *Bouteloua oligostachya*, Torr. Blue grama [Fig. 6].

This is today the most abundant grass of the dry plains region and is undoubtedly the richest. It grows on dry, porous non-alkaline



6. *Bouteloua oligostachya*, Torr.  
(U. S. Div. of Agros.)

soil usually, and is not found in buffalo wallows or wet places or stiff clays. On the dry benches the foliage is a mass of curly leaves covering the ground but two or three inches high at best. In some places, where new soil is washed down from the hillside above, every heavy rain, the brown fruiting stems of the blue grama are often ten inches high and thick enough to remind one of waves of wheat when the wind blows. "This grass improves very rapidly under cultivation. For several years it has grown luxuriantly in the experimental grounds of the Department at Washington, D. C., springing to green out about the middle of April and growing from 18 to 24 inches high, varying with the seasons."

19. *Bromus inermis*, L. Smooth brome grass.

This extremely valuable imported grass is slowly but surely making its way into the confidence of the people. It is very hardy. When once established it is green earliest in the spring and the latest in the fall. When not too dry it yields a stand of rich hay that all kinds of stock eat with relish.

20. *Bromus marginatus*, Nees. [Fig. 7].

This native brome grass is widely distributed from the edge of the alllands almost to the mountain tops. In the prairie portion it grows mainly in the heads of little draws putting down into ravines.

21. *Bromus Porteri*, Nash.

Has about the same distribution as the preceding, only in the prairie region it grows in clumps of small brush, like *AGROPYRON INERMUS*.

22. *Bromus Pampellianus*, Scriba. Western brome grass.

This native brome grass resembles *BROMUS INERMUS* in many of its habits. Occurs on mountain sides principally and, where the timber has been killed by fire, it gives promise of forming good forage. It was cultivated at the Ottawa experiment station and considered a very valuable grass.

23. *Bromus Richardseni*, Link.

Found in similar situations with *B. PORTERI*.

24. *Calamagrostis Canadensis acuminata*, Vasey.

In the timber on mountain sides, its broad-leaved, tender foliage may nearly cover the ground and is probably mixed with two other members of this genus. In semi-moist, partly shaded portions of mountain parks, it often furnishes large quantities of summer forage.

25. *Calamagrostis hyperborea Americana*, Kearns.

Found only in mountain parks, it grows slightly more in the open than the last.



7. *Bromus marginatus*, Nees.  
(U. S. Div. of Agros.)

26. *Calamagrostis hyperborea stenodes*, Kearn.

27. *Calamagrostis montanensis*, Scribn.

Seldom found in the mountains; these grasses grow on stiff clays, on upland alkaline lands, or even on the dry open benches. They are commonly mixed with prairie June grass (*KOELERIA CRISTATA*) and popularly confused with it.

28. *Calamagrostis purpurascens*, R. Br.

Found in bunches on the tops of mountains, on mountain ridges and among broken rocks on rugged mountain sides.

29. *Calamagrostis Suksdorfii*, Scribn.

Found under about the same conditions and often with *C. HYPERBOREA AMERICANA*.

30. *Calamovilfa longifolia*, Hack. Big Sand Grass.

This tough, broad-leaved grass is valuable to bind loose drifting sands. Commonly found in circular patches in dry sandy swales and on sandy hillsides, where it grows almost to the exclusion of all other grasses. It often covers sandy bends of the Missouri river, and is used for pasture and sometimes even for hay.

31. *Cyperaceae*. Sedges, or slough-grass.

These broad-leaved plants resemble the true grasses. They grow mostly in moist ravines and wet meadows, but one (*CAREX FILIFOLIA*, Nutt.) is also found on the driest benches with the blue grama (*BOTTELOUA OLIGOSTACHYA*). Several more grow on mountain sides and in mountain parks.

Meadows of rushes and sedges are valued highly by some on account of the fact that they furnish large quantities of hay yearly and will continue to do so indefinitely.

- 1. *Danthonia Californica*, Bol. California Oat Grass.
- 2. *Danthonia intermedia*, Vasey. Rocky Mountain Oat Grass. [Fig 8].
- 3. *Danthonia unispicata*, Munro. Tumble Grass.

These three grasses, though quite different, are also much alike, first two are usually eighteen inches high and grow scattered. Last is four to eight inches high and found in mats on the edges of little sags. All grow in the foothills, and the first two also in mountain parks, at times well up on mountain sides. In the prairie region the first occurs only in narrow strips down the bottom of dry ravines.



8. *Danthonia intermedia*, Vasey.  
(U. S. Div. of Agros.)

se tufts and tough, fibrous roots. Continued mowing and pasturing have the effect of reducing its tufts to a fairly even sod, especially in a few other grasses act as fillers.

- 5. *Distichlis spicata*, Greene. Salt grass. Alkali grass.

Wherever this grass is found, one can say with fair certainty that the soil is considerable alkali in the soil. (See alkali flats.)

- 35. *Deschampsia caespitosa*, Beauv. Tussock grass.

This grass requires about the same conditions as red-top (*AGROTIS ALBA*), and is usually found in wet meadows and swamps where there is plenty of sun. "While neither the yield nor the quality of forage is equal to that obtained from timothy or red-top, there can be no doubt that this grass fills an important place among the native meadow and pasture grasses of this region." In places where many better grasses can not grow, it often converts bogs into useful meadow lands by means of its

37. *Eatonia obtusata*, Gray. Early Bunch Grass. [Fig 9].

This grass is found in moist meadows, mainly those overflowed with water in the spring and nearly free from alkali. It makes excellent hay.

38. *Elymus Canadensis*, L. Wild Rye. Canadian Rye-Grass.

This grass is found in clumps of small brush and in moist sheltered nooks of the prairie. Mixed with other grasses in bends of creek sometimes enters largely with the hay of lowlands. It is probably most generally distributed and of the greatest value in meadows of the rye grasses here.



9. *Eatonia obtusata*, Gray.  
(U. S. Div. of Agros.)



10. *Elymus condensatus*, Presl.  
(U. S. Div. of Agros.)

39. *Elymus condensatus*, Presl. Giant rye grass. [Fig. 10].

This coarse, tough grass is found in bunches a foot or two in diameter and from four to ten feet high. It grows in nooks of high

in bends of creeks, and at times on open bottom lands. When cut for hay, it makes hay of fair quality, but becomes tough and hard to cut annually.

9. *Elymus glaucus*, Buckl. Mountain rye-grass.

This grass thrives in mountain canyons and parks and on mountain sides almost to the tops. It is seldom if ever found alone, but seems to increase in quantity in the parks as the altitude increases. It is certainly a valuable pasture and meadow grass for high altitudes.

1. *Elymus Macounii*, Vasey. Macoun's rye-grass.

2. *Elymus triticoides*, Buckl. Wild rye.

The above are two other rye grasses found in the foothills of Central Montana, but it is doubtful whether either of them is as important as the Canadian or Mountain rye-grasses.

3. *Eriocoma cuspidata*, Nutt. Indian millet.

In Central Montana this grass is mainly found in scattered patches on sandy soil or hillsides in the edge of the badlands, but is found more rarely on clayey soil and in the foothills. The foliage is tough and wiry.

4. *Festuca campestris*, Ryd. Snow grass.

In portions of the foothills partly sheltered by mountains and in portions of mountain parks, this grass grows nearly alone. In such places, it is found on mounds similar to the tussocks on which certain sedge grasses grow. From the top of these its long leaves loop over all sides. It makes good pasturage, as it starts as soon as the snow melts in the spring, but it is extremely difficult to mow for hay. It is also found scattered in mountain parks, where it does not grow in mounds and forms only a small portion of the forage, but when mixed with other grasses may form valuable meadows.

5. *Festuca octoflora*, Walt. Slender fescue.

This strange little annual is found widely scattered over the plains portion of the country. Stock leave it, even when the blue grama is mowed to the ground.

46. *Festuca ovina*, L. Sheep Fescue. [FIG 11].

47. *Festuca rubra*, L. Red Fescue.

On the upland benches of the foothills, on mountain ridges and the drier portion of mountain parks, these two valuable grasses furnish the greater part of the forage and are together known as bunchgrass. More or less scattered they are found on down to the edge of the meadows. In their habit they resemble the blue grama, which is most absent here.



11. *Festuca ovina*, L.  
(U. S. Div. of Agros.)



12. *Hordeum jubatum*, L. (U. S. Div. of

They grow in little circular bunches two or three inches over and under many varieties.

48. *Hordeum cespitosum*, Scribn.

49. *Hordeum jubatum*, L. Squirrel Tail Grass. [FIG 12].

These two grasses, commonly known as "foxtail" through the country, are apt to be bad weeds on moist semi-alkaline soil. They are found around the edge of intermittent pond holes mixed with hair-grass (*AGROSTIS HIEMALIS*) and in strongly alkaline meadows mixed with salt-grass (*DISTICHLIS SPICATA*).

50. *Hordeum pusillum*, Nutt. Little barley.

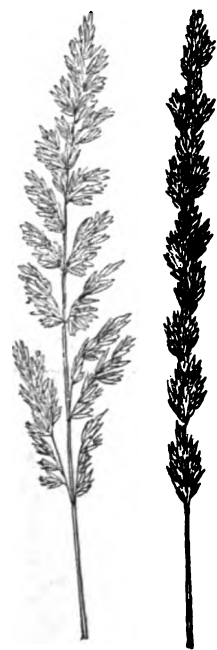
This little pest grows similar to slender fescue (*FESTUCA OCTOFLORA*), crowding out the blue grama, and is not eaten by stock. It is mainly found in the edge of the badlands.

51. *Juncaceae*. Rushes, or wire grass.

Small plants resembling the grasses growing in clumps along the bottom of dry ravines, and in moist meadows mixed with sedges. Their hay is low in food value, but is often cut in large quantity.

52. *Koeleria cristata*, Pers. Prairie June Grass. [FIG 13.]

This early grass rarely grows alone but adds greatly to the forage conditions. It is found on the top of the driest hills and well down into the wet meadows. On alkaline land, if any grass except salt-grass will grow, it is apt to be found. Found throughout the badlands, prairie benches, foothills, mountain parks and is apt to be seen on the mountain sides as high as the grass will grow. It is the



53. *Koeleria cristata*, Pers.  
(U. S. Div. of Agros.)

most widely distributed grass of the region. It matures early, comes up and furnishes a large quantity of seed. It is one of the first to afford pasturage in the spring and is much relished by stock.

53. *Melica cepacea*, Scribn.  
Slender-Flowered Melic-  
Grass.

Found in shady portions of  
Belt park only.

54. *Muhlenbergia racemosa*,  
B. S. P. Satin Grass. Wild  
Timothy. [FIG 14].

Found on gravelly soil  
around the edge of thickets,  
about a mile above Armington  
only.



14. *Muhlenbergia racemosa*, R. S. P.  
(U. S. Div. of Agros.)

*Panicularia Americana*, MacM. Reed Meadow Grass. [FIG 15].

*Panicularia nervata*, Kuntze. Foul Meadow Grass.

*Phalaris arundinacea*, L. Reed canary grass. [Fig. 16].

These are usually found along stream margins and in low ground.

Some grow two feet, and the last four feet high. Under favorable conditions, they produce fair hay. The last is by far the most

Some think it can be cultivated to advantage on land that produces only rushes and sedges. It will not endure alkali.



*Panicularia Americana*, MacM.  
(U. S. Div. of Agros.)



16. *Phalaris arundinacea*, L.  
(U. S. Div. of Agros.)

58. *Phleum alpinum*, L. Mountain timothy. [Fig. 17].

59. *Phleum pratense*. L. Timothy.

The first is a native at high altitudes in mountain regions, while the last is one of the best known and most widely cultivated of the imported grasses. In mountain regions the latter has spread so rapidly of late years that it is difficult to say which is now in the greatest abundance. In mountain meadows they form at times very large po



17. *Phleum alpinum*, L.  
(U. S. Div. of Agros.)



18. *Poa lucida*, Vasey.  
(U. S. Div. of Agros.)

us of the vegetation. The writer found patches where the common  
othy had crowded out the native grasses so completely that it was  
icult to believe that it had not been sowed on plowed ground.

0. *Poa laevigata*, Scribn. Smooth Bunch Grass.

1. *Poa lucida*, Vasey. Pale Bunch Grass. [FIG 18.]

These grasses are found widely scattered over the prairie benches,  
do not fill anywhere near as important a place as formerly. In  
adows overflowed by spring runs or irrigated moderately they  
ke fine hay.

2. *Poa nemoralis*, L. Wood Meadow Grass.

3. *Poa Nevadensis*, Vasey. Nevada Blue-Grass.

4. *Poa rupicola*, Nash.

This was found in a few places on the prairie and on the tops of  
mountains. It resembles the other meadow grasses in appearance  
habits of growth.

5. *Puccinellia airoides*, W. & C. Alkali Meadow Grass. [FIG 19.]



*Puccinellia airoides*. Watts. & Coult.  
(U. S. Div. of Agros.)

This grass is principally found  
as one of the constituents of wet  
meadows. "It is not as well liked  
by stock as many other grasses.  
It possesses, however, alkali resist-  
ant qualities, which enables it to  
grow in soils which better grasses  
can not endure."

66. *Schedonnardus panicula-  
tus*, Trel. Crab Grass.

This annual was found in old  
ruts in Sand Coulee, east of Great  
Falls.

67. *Sitanion rigidum*, J. G. S.

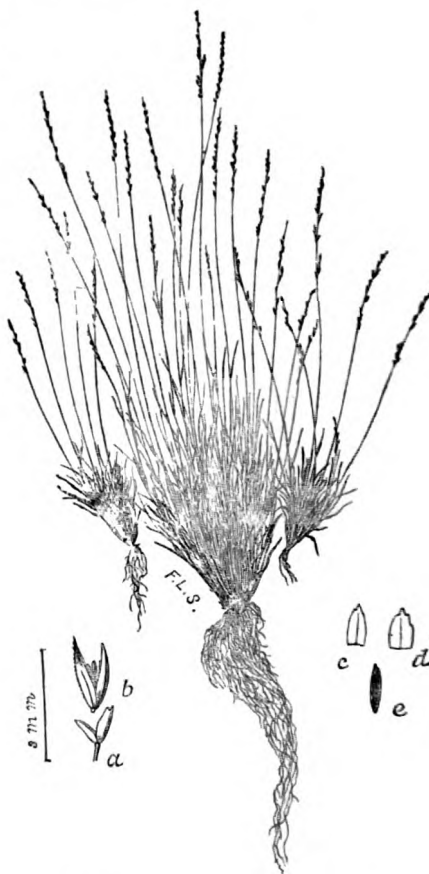
This stiff, long-bearded grass grows on rocky mountain tops, and at Square Butte, and among broken igneous rocks and limestone on rugged mountain sides. For stock, it is far worse than the squirrel-tail grass (*HORDEUM JUBATUM*).

68. *Spartina cynosuroides*, Willd. Big Cord Grass. [Fig 20].

This grass grows in or near shallow water, and adds to the forage of wet meadows. It is tough and generally avoided by stock.



20. *Spartina cynosuroides*, Willd.  
(U. S. Div. Agros).



21. *Sporobolus brevifolius*, Scribn.  
(U. S. Div. Agros).

69. *Sporobolus asperifolius*, Thurb. Rough-Leaved Salt-Grass.

Grows well on strongly alkaline soil and has little more value than salt-grass (*DISTICHLIS SPICATA*).

70. *Sporobolus brevifolius*, Scribn. Prairie Rush Grass. [Fig 21].

Scattered from the edge of the mountain region to well down into the badlands; thrives under all conditions except on the dry bench lands. It grows in patches thick on the ground and from four inches to two feet high, depending upon the amount of moisture. On the ranges, however, sheep leave it until the blue grama is gone. This grass gives promise of great value, as it withstands alkali well and in moist meadows furnishes a surprising amount of hay.

71. *Sporobolus cryptandrus*, Gray. Sand Rush Grass.

Grows in scattered bunches in sandy places, mainly in the badlands.

72. *Stipa comata*, F. & R. Needle Grass. [Fig 22].

This grass is widely scattered over the benches of the open country and its foliage is rich in food for stock. Its needles, however, are very sharp, and getting into wool, often penetrate the skin.

73. *Stipa Richardsonii*, Gray. Richardson's Feather Grass.

Found in the edge of the mountain region only. It appears to be inferior to *STIPA VIRIDULA* in value.

74. *Stipa spartea*, Trin. Porcupine Grass. Devil's Needles.



22. *Stipa comata*, Trin. & Rupr.  
(U. S. Div. Agros).

Resembles *STIPA COMATA*, but is taller and more erect, growing in the foothills mainly. Its needles are also sharper, longer and stiffer, and are more injurious to stock.

75. *Stipa viridula*, Vasey. Feather Bunch-Grass.

Usually grows in small bunches, but sometimes scattered, stiff plastic clays of the badlands, and in nearly every semi-moist no and corner of a hilly country, y never in great quantity anywhere. In the foothills and mountains parks, it grows more in the open and often adds to the general value of the forage; does well under irrigation.



76. *Trisetum subspicatum*, Beauv. Downy Oat-Grass.  
[FIG 23].

Growing mainly on mountain sides and ridges and in mountain parks. This grass flourishes in a variety of soils, but is most commonly found in moist open woods lands or in the edge of thickets.

23. *Trisetum subspicatum*, Beauv.  
(U. S. Div. of Agros).

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**AGRICULTURAL**

**EXPERIMENT STATION**

**-- OF THE --**

**AGRICULTURAL COLLEGE OF MONTANA.**

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**PORK PRODUCTION**

**IN MONTANA.**

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**BOZEMAN, MONTANA, SEPTEMBER, 1902.**

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**BOZEMAN CHRONICLE,**  
Bozeman, Montana,  
1902.

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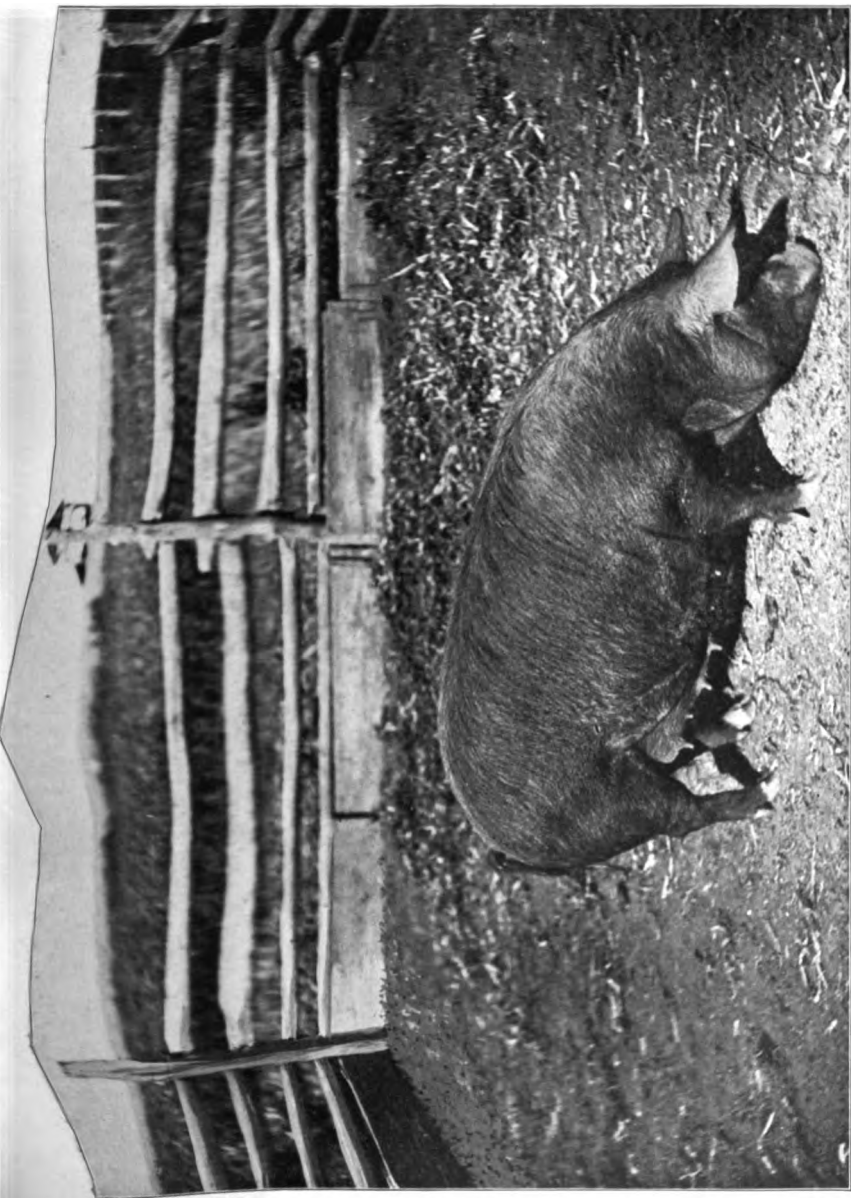
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# Montana Experiment Station.

Bulletin No. 37. - - September, 1902.

## PORK PRODUCTION IN MONTANA.

BY R. S. SHAW.

The industry of pork production is in great need of encouragement throughout the arid west, which supplies but a small percentage of the pork required for home consumption. Western towns and cities are in large measure supplied with cured pork from the great packing houses of the east, with a product from corn producing regions. There is a great demand for large quantities of cured pork in Montana. The occupations and conditions surrounding the people are such that large quantities of cured meat must be used of which pork is the chief. Ranchmen, stockmen, railroad and canal builders, miners, prospectors and others living in places remote from the large centers can neither obtain nor handle fresh meats to good advantage. In many instances our farmers still continue to purchase cured bacon and ham, bearing packing house brands, from local merchants instead of producing them on the farm. Because of these practices our western farmers are failing to obtain a large revenue which they could so easily secure. Pork cannot be produced more cheaply or of better quality than in the irrigated regions of the arid west. Pig raising has been made possible by the opening up of agricultural lands which are made to produce enormous quantities of cereals and legumes by means of irrigation.

### SUITABILITY OF CLIMATE.

The climate of the arid west is characterized by a light, dry air, prevailing sunshine and moderate temperature. No better combination of conditions exists for the healthy and rapid development of the pig. The cultivated regions are in general found between the altitudes of 2000 and 5500 feet, where little or no damp, muggy weather occurs. These atmospheric conditions combined with an almost continued sunshine throughout the winter season

lessens, in fact almost entirely prevents, the occurrence of the many pig troubles so disastrous in the more humid regions. Throughout these regions extremes of temperature are not prevalent during long periods of time, and being short lived are easily endured because of the lack of humidity. In general the climatic conditions are such that the pig can run out of doors throughout almost the entire year, the snow fall being very light. These conditions tend toward vigor and healthfulness and permit of economic methods of feeding. Everywhere it is possible to provide abundant supplies of clear sparkling water from the mountain streams. A number of instances have been noticed in which breeding hogs imported from the corn belt have brought hog cholera among our western bred stocks. In one case 60 per cent. of imported hogs died while only one mature hog out of two Montana grown ones succumbed, although all were effected. From this we have strong evidences of the constitutional vigor produced by the climatic and food conditions.

#### SUITABILITY OF FOOD PRODUCTS.

The pork producing foods grown in the arable regions of Montana consists of cereals, legumes and root crops, the marvelous productiveness of which has been heretofore described. The cereals include brewing and white and black hulless barley, spring club wheat, rye and oats. One legume, viz. peas, can be universally grown in great profusion. Forage crops, alfalfa, red, alsike and white clovers, peas, winter and spring rye and various grass mixtures produce an abundant variety of pasture throughout for eight months of the year. Of the root crops best suited, sugar beets, mangolds and carrots can all be raised. While the great variety enumerated cannot all be grown in each cultivated section, still, there is no farm territory in Montana where a suitable combination of these cannot be grown. It is true that winter rye cannot be universally grown, and no section need be without some one or more of the legumes, cereals and root crops. It therefore follows that excellently balanced rations can be secured generally which will produce a good quality of pork, rapidly, cheaply and economically. It may appear to those from the corn belt that the inability to grow corn in most parts of Montana is a strong argument against the business. In peas, however, we have an excellent substitute for corn. Bulletins 34 of the Utah Station by Mills, and

the South Dakota Station by Chilcott, both report peas superior to corn for fattening swine. Barley is reported by the famous Danish pork producers to be the best single grain for the production of high grade bacon. Director Henry of the Wisconsin Station gives the following comparison between corn and barley as pork producers, viz.:

471 pounds of barley meal produced 100 pounds of gain.

435 pounds of corn meal produced 100 pounds of gain.

Wheat—The results of several stations show wheat and corn to be nearly equal in pork producing value with a very slight advantage in favor of corn.

Oats—According to Henry's "Feeds and Feeding," the Massachusetts Station reports that 20 per cent. more oat feed than corn meal was required to produce 100 pounds of gain. Oats are more valuable as an adjunct to lighten heavier rations than when used alone.

Rye—The results of comparative work shows rye and barley to have about equal feeding values. These facts tend to prove that grain foods are exceptionally well adapted to pork making, and at the same time the use of these is greatly facilitated by the possibility of a continuous supply of nitrogenous forage crops during a long growing season, and by root crops in the winter.

#### PREPARING FEEDING FOODS.

The most satisfactory results have been secured from grinding the grain feeds and soaking a short time before feeding. Under the best conditions the cereal grains become so hard and flinty that they cannot be fed whole with good results. Local facilities are now such that grains can be ground at little expense. Where it becomes a necessity to feed whole grain this can be accomplished by cracking it on hard dry ground or a feeding floor, it will then be picked up little by little and is more likely to be masticated, where, if fed in troughs large quantities are swallowed, passing the digestive tract whole. Prices of labor are so high as to render the cracking of either grains or roots too expensive. Root crops can be fed to good advantage raw except where turnips or rutabagas are used.

#### FORAGE CROPS.

The climatic conditions and capabilities of crop production are such that pigs, old, young, breeders and fatteners, can forage dur-

ing fully two-thirds of the year. The secret of economy in production in Montana, consists in keeping the pigs foraging. Even though some expert investigations reveal the fact that a pig enclosed in a pen will make a greater gain from a given number of pounds of food than the pig running at large, still, it will pay better because of the cost of labor to let the pig go to the food than to bring the food to the pig. A succession of forage crops must be provided for, which means that from three to four lots should be fenced off near the hog houses. If alfalfa alone is relied on, it should be divided into two parts to permit of recuperation and rotation. Forage crops may be relied on for use in the following order, winter rye in April, alfalfa in May, the clovers in June, and mixtures in July, and peas from August to the setting in of winter. These are the periods at which each of the crops named come into use. Of these crops alfalfa is one of the most important because of its permanency; where it cannot be grown some one of the clovers is sure to answer. Alsike clover is well adapted to moist situations and withstands very severe grazing. White clover will grow in a still wetter soil. Through the use of a liberal amount of forage, not more than four or five acres of forage is necessary to provide green food for a herd of from 40 to 50 pigs of all ages, and the opening up of spring till the pea crop and grain stubbles be accessible. Young growing pigs should not be required to forage for a living; a one-third grain ration should be supplied in addition to secure a proper growth and development. Foraging alone will only provide maintenance and a small gain in live weight. A light grain ration advocated will materially assist in producing remunerative gains and prepare the young pig for fattening on grain stubbles or peas in the autumn.

### METHODS OF FEEDING.

#### THE BROOD SOW.

The brood sow can forage the greater part of the year. During the later stages of pregnancy a little grain food should be supplied, the amount depending upon her condition of flesh; this, however, will not be necessary during the time she is gleaning from the fields. The forage in general being leguminous any one of the cereal grains may be used as supplementary food. While nursing the litter access should always be given to the forage grounds, if possible, and a liberal grain ration fed. Immediately after farrowing

g a light ration of sloppy feed consisting of skim milk, shorts, bran and oats is most satisfactory; the heavier grain foods can be gradually added. During the period of rest or early pregnancy in the winter months the brood sow can be maintained on sugar beets, carrots or mangolds with a one-third grain ration added. Spring farrowing has hitherto been favored, but the climatic and food conditions are such that fall litters can be handled almost equally well.

#### **YOUNG AND STORE PIGS.**

These should have constant access to forage grounds in the summer season, and sheltered yards in the winter. When four weeks old they will take a little sweet skim milk to which some shorts or middlings may be gradually added, and later some ground wheat. A light grain ration should be supplied the young growing pig in addition to the forage throughout the forage season but may be entirely cut off as soon as the pigs reach the pea or grain stubble fields. During the winter season the shotes should have access to stacked alfalfa, clover, or peas, from which they will secure a large amount of food. Sugar beets should also be supplied.

#### **THE FATTENING HOGS.**

This process is most economically accomplished by finishing in the pea lots or grain stubble. The pigs should be turned on the peas as soon as the pods are filled and the peas begin to harden. If sufficient pigs are used, say 10 per acre, not a pea will be wasted and even a portion of the vines consumed. One acre of peas, producing at the rate of 35 bushels per acre, which is an average for Montana, will provide a fattening ration for ten 150 to 200 pound hogs for from 40 to 45 days. Climatic conditions permit of pea harvesting by pigs even as late as December 1. This is one of the easiest fattening methods now practiced in Montana. The area over which peas can be grown is very large and the time of foraging so extended by favorable weather that the product need not all be marketed at one time. In order, however, to make the best use of forage conditions, winter litters must be raised. Pigs from spring litters do not reach a large consuming capacity soon enough to take advantage of the early forage. Both late fall and early spring litters should be raised in order to get the most out of the foods and the market conditions.

#### **RESULTS FROM GLEANING GRAIN FIELDS.**

Enormous quantities of pork could be made annually from the grains wasted on stubble fields, large quantities of which are lost by "shattering" under the arid conditions.

During a period of 42 days extending from Oct. 4 to Nov. 1901, the following test was made with pigs gleaned from stubble from which crops of oats, wheat, barley and peas had been removed. At the beginning of the test the 24 pigs weighed 2700 pounds and at the close 3608 pounds. Thus in 42 days 24 pigs made an increase in live weight of 874 pounds, which amount valued at 46 cents, the prevailing price at the time, gave a return of \$46. From this amount \$3.28 is deducted for feed during a few days when the ground was covered with snow, there was then a clear profit of \$42.76. The percentage increase in live weight was 32.1 per cent. as compared with 19.2 per cent. from lambs and 5.19 per cent. from steers under the same conditions. One hundred and twelve acres of the station farm, consisting of meadow, pasture, and the balance of stubble, formed the run for the 24 pigs, 230 lambs and 11 steers. There are enormous areas in Montana which could be put to a similar use.

#### RESULTS SECURED FROM FEEDING GRAIN VS. GRAIN AND SUGAR BEETS.

In the spring of 1902, two lots of four pigs each were fed for 50 days, one on exclusive grain ration, the other receiving grain and sugar beets, with the following results. The four pigs receiving grain made an increase of 316 pounds or 79 pounds each, making an average daily gain of 1.58 pounds. The cost of production per pound increase with this lot was 4.6 cents. The four hogs receiving grain and sugar beets made an increase of 328 pounds or 82 pounds each, making an average daily gain of 1.66 pounds. The cost of production in this case was 3.8 cents per pound. The former lot received a heavy grain ration of 6.65 pounds each per day. The latter consumed 6.65 pounds of grain and 4.58 pounds of sugar beets per head per day. The final outcome of this test resulted in a net profit of \$14.12 or 33.3 per cent. on the investment in 50 days. Previous tests conducted in 1900 gave the following results:

Cost of pork per pound increase from grain only.....	\$3.28
Cost of pork per pound increase from grain and sugar beets.....	2.40
Food required per pound increase from grain only.....	5.32 lb
Grain required per pound increase from grain and sugar beets, 4.26 lb	
Net profit per head from feeding grain only.....	\$1.12
Net profit per head from feeding grain and sugar beets.....	2.00

One acre can be made to produce from 15 to 20 tons of sugar beets at a cost not exceeding \$30 per acre. If for any reason

cannot be grown carrots or mangolds can be made to take their place. Some insect pests which prey upon the young sugar beets and mangold plants will not harm the carrots. These roots can be fed whole and raw, at least expense, with satisfactory results. The sugar beet is the best keeper of the three.

#### THE KIND OF HOGS TO BREED.

Our conditions are well able to support large framed hogs which will mature moderately early. Strength of bone is desirable but not so necessary as in some other regions. The brood sow should be long bodied and rangy with good length and depth of coupling; such a one is more sure to be prolific, a good mother, and good nurse, than the chunky, compact, fine boned, strictly lard type. These desirable features are found par excellence in the improved English Berkshire and good results can be secured from the large, rangy, strong types of Poland Chinas. Many of our breeders are making serious mistakes by breeding immature animals and so by inbreeding. Let the young sow reach ten or twelve months of age before producing her first litter, and then do not destroy her as long as she continues to produce good ones. Inbreeding has arisen because of the difficulty and cost of importing boars; judiciously practiced, rapid deterioration of form, constitutional vigor and feeding qualities is sure to ensue.

#### HOG HOUSES.

Various improvised and inexpensive shelters are being used, from the dugout in the hillside to the pole shelter covered with straw and the building made of logs. While any of these may provide shelter during the milder portion of the year, their use can in no wise prove satisfactory throughout. They are too apt to be dark, damp, filthy and draughty. The pole structure with a straw covering may be used as a temporary shelter or for sleeping quarters or feeding hogs during the milder season, but for breeding quarters their use cannot be recommended. The log building is in most common use. Its greatest fault is its inability to retain the chinking. As a result the structure soon becomes open and draughty.

A properly planned and well constructed frame building gives the best results; its use is almost absolutely necessary where winter breeding is practiced. The building site should be high and dry so that surface water will drain away at all times. If possible the location should be in close proximity to the small fields which are

to produce the forage crop. If a natural water supply can be diverted so as to pass through the yards so much the better.

It is desirable that the hog house should face the south, that each pen should open into a small enclosure fenced off, preferably with wire netting. By this means when a number of sows confined with young pigs during the winter season they can have access to protected, sunny yards.

The size of the building will be determined by the number of brood sows and boars to be kept. As regards shape a long narrow building is preferable, of such proportions, for instance, as 48. In such a structure a  $3\frac{1}{2}$  foot passage way should run from end to end along the north side of the building, thus leaving all pens on the south side. Pens  $8 \times 12\frac{1}{2}$  will furnish room for a brood sow and litter or several fattening pigs, according to space. One pen of twice the capacity should be constructed to furnish sleeping quarters for a larger number of animals, although an extra shed could be constructed cheaply to protect the animals during the pasture season. Each pen should be provided with a sliding hinged door on the south, and directly above it a window. If more than two windows will be required on the north side. Troughs should be placed directly under the partition adjoining the passage way, and this partition so constructed as to swing from the top. In this way the pigs can be excluded from the trough while the feed is being supplied. The swinging partition is held in place by means of a slide in the center which works up and down thus resting on either side of the trough as desired. Less food is wasted when the flat bottomed troughs are used. Because of the splintery nature hemlock makes a durable trough, the pigs are loath to caring to chew it.

Concrete overlaid with cement furnishes a good flooring the only fault being that it is cold. This may be overcome by covering with a small portion with plank for a bedding place. Plank floors give good satisfaction but should be made water tight otherwise much filth will work through and produce unsanitary conditions.

One or two ventilators should extend from within a few feet above the floor up through the roof; in many cases these do not extend below the ceiling and as a result remove only the upper warm air leaving the foul, heavier air below. If necessary to secure warm air the inside may be lined and the spaces between the studs filled with sawdust or chaff. The chief essentials of a good hog house are warmth, sunlight, dryness and good ventilation without draughts.

*See 1035.3571*

LETIN NO. 38. ✓

**MONTANA AGRICULTURAL**

# **Experiment Station**

**OF THE**

**AGRICULTURAL COLLEGE OF MONTANA.**

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**FOOD ADULTERATION.**

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**BOZEMAN, MONTANA, OCTOBER 1, 1902.**

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**1902.**

**The Avant Courier Publishing Co.  
Bozeman, Montana.**

# Montana Agricultural Experiment Station

Bozeman, Montana.

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# Montana Experiment Station.

Vol. No. 38

October, 1902

## FOOD ADULTERATION.

F. W. TRAPHAGEN.

As a class the Montana Farmers should be more deeply interested in the subject of the adulteration of food and in the remedies for existing conditions, than any other group of citizens of our commonwealth. The reasons for the existence of this interest are twofold, namely, because as producers they suffer greatly by having their products come into competition with the cheaper spurious products which so completely flood the markets today, and because as consumers they are constantly buying foods which are not true and pure, but are either partly or entirely made up by the substitution of cheaper materials.

Unfortunately the stress of the competition of low grade imitations of our own farm crops has not yet been felt to any great extent. That our farmers have this competition to meet in the future unless remedies are enacted for their relief, is shown by the fact that already, on a very small scale, the manufacture of preserves and jellies has been undertaken near Missoula, and the sale of these high grade products has been seriously affected by the presence of so much of the cheaper "compounds" which are so plentiful in all our markets.

### Nature of Food Adulteration.

For our purpose it will be sufficient to divide the adulteration of foods into two groups, first those which affect the pocket-book, and second those which affect the health.

In the first group we would place all cases of the substitution, in whole or in part, of cheaper, though wholesome, articles for the one which is presumably bought. Examples are the use of glucose for maple syrup, or for New Orleans molasses, or its substitution for more expensive and sweeter sugar which is used in the higher grade jams, preserves and jellies. Corn meal is frequently used to adulterate wheat flour; cotton seed oil, peanut oil and sesame oil are masquerade as olive oil, ground spices are composed largely of ground cocoanut shells, and similar substitutions are made for other food materials.

Under the head of unwholesome adulterations would be placed those instances which cause derangements of the digestive or other func-

tions of the human economy. Examples of these are the green rock which was sold by the York Manufacturing Co., of Greenville, N. C., in carload lots for the adulteration of wheat flour. It is once apparent that this material can have no nutritive value and it further must tax the digestive organs greatly to effect its elimination.

We have been called a "nation of dyspeptics," that this name justly applied is due to the fact that the use of food preservatives which is prohibited in several foreign countries, is not restricted in this country except in the few states having effective food laws.

The case against these food preservatives is not as complete as it might be, but in the event of a reasonable doubt it is best to be on the safe side. The food preservatives in use at the present day are powerful antiseptics and for that reason have a decided restraining effect upon digestion. The question of the physiological effect of extremely small quantities of any of these preservatives that would be taken with food when the minimum amount necessary for its preservation is used, is very important. It is probable that in such cases the vast majority of consumers would not be harmed. On the other hand, in the case of children or invalids much harm might result even with the smallest amounts of antiseptics. Where the use of such drugs as these preservatives is contra-indicated, it should be as far as possible to avoid their presence in the foods consumed.

The arguments against the use of chemical preservatives are made with almost equal force to the artificial colors which are used so largely to improve the appearance of inferior goods. The testimony of experts on physiological chemistry given before the Committee on Manufactures of the United States Senate in its investigation of this matter, shows the prevailing opinion of those best qualified to testify on this subject.

A portion of this testimony is given in the Seventh Annual Report of the Montana Bureau of Agriculture, Labor and Industry, pages 499—507, and our readers are referred to this report.

### **The Remedy**

After a futile attempt to secure the passage of a measure by the legislature for the protection of the citizens of our commonwealth we have reached the conclusion that the best way to secure reform is through the enactment of a measure by Congress.

The reason for this change of base on our part is primarily because such a measure, as was considered by our legislature, can only become effective by holding our own dealers responsible for the character of the foods they offer for sale. In the nature of things we cannot successfully legislate against producers or jobbers who reside in another state than our own. At the same time there is no doubt but that our dealers could protect themselves by exacting guarantees from their supply houses. That the wholesalers are willing to give such guarantees we have been assured by

representatives of many of the firms doing business with Montana mailers.

Yet, the plea that the innocent (?) Montana merchant would bear burden of prosecution, or persecution, as some of the grocery-lobbyists chose to put it, proved a very effective argument with members of the last Montana House. The difficulties of the administration of such a law as was proposed would have been great and there is no doubt that the work can be much better done by the Bureau of Chemistry of the Department of Agriculture at Washington than by the individual states. Of course a national law can only deal with interstate commerce in such goods, and with violations in the District of Columbia and in the Territories, hence the states will have to take care of all such violations of food laws as occur within their own limits. This phase of the problem need not trouble us for many years, for so far as we know, our own food products thus far have been above suspicion, and we believe will remain so for many years. A national pure food measure which we believe to be necessary to supplement the laws already in force in some states, and to afford protection to citizens of states having no laws on this subject, would be a boon to the farmer when he is considered either as a producer or as a consumer. The bills before the last session of Congress known as the Hansbrough Bill in the Senate, and the Hepburn in the House of Representatives, seem to be perfectly fair in every respect, and had the endorsement of numerous organizations which have no private "axes to grind."

The text of the Brosius Bill may be found on pages 489-492, Twelfth Annual Report Montana Bureau of Agriculture. This bill is practically identical with the other bills mentioned.

When considered briefly in their essential details they place the administration of the law in the hands of the Secretary of Agriculture, with the details of administration given to the Bureau of Chemistry, which for years under the lead of the Chief Chemist, has been making exhaustive researches along all the lines involved in the successful enforcement of an anti-falsification law.

There is no doubt that there is no laboratory nor corps of chemists well fitted for such work as that to be found in the Department of Agriculture.

The bills make no prohibitions, but simply demand that articles be judged on their merits for what they are, and that they do not masquerade as something better.

The correct locality of production must appear, so that a state producing a particularly high grade of flour or superfine butter, may not be robbed of its honors by the false branding of other flour or butter, perhaps pure enough, but still decidedly inferior, and produced in some state which has yet to make a record in these lines. These matters are of immediate concern to farmers.

The opponents of these bills offer arguments, or rather an argument, which should disgrace any men. They protest that to call them to label glucose syrup correctly, and prevent them calling it maple syrup, is an infringement of personal liberty and an interference with their Constitutional rights. How a man can expose himself to the supreme contempt of his fellow men by such an argument is beyond our comprehension. Yet this is precisely what many did in the public hearing of the supporters and opponents of these bills when they were before the respective committees having the charge.

For the protection of our agricultural and horticultural interests it would be well if the numerous organizations, representing these industries, would become familiar with these measures now before Congress, and would use their influence to secure the passage of a suitable bill, such as the ones before mentioned.

#### **The Conditions in Montana.**

It will not be surprising to learn that, because of the absence of protective measures of any kind, adulterated food is common in Montana.

The adulterations are of both kinds, the deleterious and the fraudulent. Jams, jellies, preserves and catsups are found very generally colored with coal tar dyes, and when this is done it is almost always an evidence that it is simply done to hide another adulterant, such as starch paste, glucose or other cheap substitutes for the real food. When a preservative such as salicylic acid is used, its presence may be assumed to indicate the presence of glucose, or some other readily fermentable substitute in place of a usual constituent.

As a matter of fact, the two substances just mentioned were commonly found, and in addition, starch paste and glucose were their frequent companions. In the case of catsups the preservative is used mainly, not because of any substitution, but because the catsup is particularly subject to fermentation on account of the manner of using this condiment.

Vinegar was usually found sufficiently sour to pass muster in its place but its origin was frequently doubtful, and rarely was it made from apple juice.

To show how effective a national law may prove, it is only necessary to mention our experience in seeking oleomargarine in Montana markets. While it is known that it is bought in the national packages for sheep camps, and possibly for grading crews in a few other cases, we suspected it might be on sale on the market as butter. We were assured by the collector of internal revenue that none was retailed in Montana, but we wished to mine for ourselves how true this statement was. With this object in view we hired a small boy to buy for us in many stores the cheapest butter offered for sale. To our great surprise, while of course the samples were not the highest grade of butter, yet not one of the

was anything but butter. There was no evidence of the presence of lard or oleomargarine in any one of the samples.

### **Jams, Jellies and Preserves.**

Probably no class of food materials is more generally adulterated than the jams, jellies and preserves. It is possible to get samples purporting to be one of these preserved fruit products which contains fruit whatever. We have found samples in this state which contained glucose, starch paste, salicylic acid, a coal tar dye and some seeds which are likely the seeds of grass rather than of fruit. This surprised the contents of one of the jars of jam which we examined. In another series of jams there was a small amount of fruit in such a proportion as would allow of its easy recognition, but the great mass of the jam was made up of glucose syrup and starch paste, with a considerable amount of salicylic acid added to prevent fermentation. See table of analysis on following pages.

### **Canned Soups.**

In general, very little adulteration was found to be present in the canned soups examined. However, this is true of all the samples, and a dilution on the extent indicated on the label made an extremely "thin" soup, and at best the food values so obtained were extremely insubstantial. As a convenient and easily prepared food, these soups furnish an article that is all that could be desired, but as a part of an economical dietary they have no place.

See table of analysis on following pages.

### **Tomato Catsups.**

It is doubtful if any article of diet so generally contains preservatives as do tomato catsups. The addition of preservatives to this class of foods becomes necessary because the article is not entirely stable up as soon as opened, but may be placed upon the table day after day, and a little used at a time. The preservatives used most commonly are salicylic acid and benzoic acid, but others are occasionally used.

See table of analysis on following pages.

### **Cream of Tartar.**

To make use of a form of expression commonly known as the "cream of tartar bill," many of the cream of tartars on sale in our state are something else; that is they contain no cream of tartar whatever. This is a condition that would be remedied by the operation of such a law as is comprised in the Brosius bill.

In many instances our merchants know what they are purchasing, yet they sell these inferior goods under false names, and for inferior materials; the price however, is not lower. These so-called "cream of tartars" are what are known in the trade as "C. T. S." That is, cream of tartar substitute, an article made up of burnt alum, acid calcium phosphate, or some other cheap acid constituent to take the place of the higher priced cream of tartar. Usually starch,

gypsum or some other worthless filler is added in addition.

One of the retailers told me he knew the sample I had just sent him was not cream of tartar, yet he did not hesitate to sell it under a false name. In many respects some of our retailers are more honest than the wholesaler who supplies their goods.

### **Baking Powder.**

Four years ago when these investigations were undertaken for the first time, a very considerable number of low-grade baking powders were on the market. This year we have found a decided improvement, for not only have many of the lower grades disappeared from the state, but in addition there has been a decided improvement in the better grades.

The value of baking powder is primarily determined by the amount of gas eliminated by it under the conditions associated with the kneading and baking of bread. There is another consideration, however, which is very important, and that is as to how the residues from the baking powders exist in the bread, and what the effect of such compounds is upon the human system. In making bread with yeast the principal products of the action of the yeast plants are the gas and the alcohol, the latter of which is entirely dissipated during the baking.

Cream of tartar baking powders leave in the bread the residue of tartrate of sodium and potassium, which is commonly known as Rochelle salt, so frequently used as a laxative. The phosphates of sodium are changed during the bread-making process into phosphates of calcium and sodium, neither of which may be considered harmful, and which may even have an important function in bone and tissue formation.

Of another type of baking powders, and of still another type to a degree, one cannot be quite so confident of the harmlessness of the residual materials. These are the alum and the alum phosphate baking powders. It is true that only small amounts of alum may be in a form capable of being dissolved by the digestive fluids, yet, on the other hand, we know of the harmful effects of large quantities of soluble aluminum salts. These salts have the power of interfering with the processes of digestion, and while there is no certain evidence that the small amounts present in bread and biscuit made with alum baking powders will produce harm, yet the preponderant opinion of experts is unfavorable to their use.

See table of analysis on following pages.

### **Vinegar.**

It is a fact that most of our citizens pay little attention to the nature of the vinegar they use. Vinegar is usually purchased only as a material for rendering other foods sour, but quite a preference for the fine flavor possessed by the better grades. In this preference is generally given to the vinegar made from apples.

it is supposed that such vinegar is what we usually get in stores. Highly esteemed is the cider vinegar that it commands a distinctly higher price, and vinegars from other sources are made to imitate it as early as possible.

On inquiry in this state it developed, to our great surprise, that to the ordinary consumer vinegar was vinegar, no matter what the source, and that there was very rarely a call for a cider vinegar. As a matter of fact, there is little pure cider vinegar on sale in this state, but much imitation cider vinegar is sold in its stead. As far as the strength of the vinegars is concerned, there is little to complain of, the standard of from 4 to 5 per cent. acid required in our states being usually found.

The practice of one firm of manufacturers is most reprehensible, and calls for severe condemnation. Sample jugs of apple cider of excellent quality are sent out by Wallace and Gregory Bros., of Paducah Kentucky, and a totally different vinegar is sent in the same packages, even though the same quality was promised the dealer. This was the experience of at least one of our retail grocers, Gary Bros., of Bozeman.

#### **The Use of Preservatives.**

The question of the continued use of the small quantities of antiseptics which are present in so many foods is an important one. There is no doubt that these antiseptics prevent, to a greater or less degree, the digestion of foods, and anything that hinders digestion is hardly desirable in food. It is entirely likely that a strong opinion may use repeatedly food containing such adulterants, but if it is because his powers of digestion are sufficiently great to overcome their inhibitory effect. With persons of weak digestive power, foods so preserved can hardly prove other than harmful. On the whole, it seems only fair that we should know exactly what we are eating, and that we should be in a position to avoid that which is harmful. In this connection the testimony given before the Senate Committee on Manufactures is pertinent to the discussion. This will be found in the report previously referred to.

#### **Occurrence of Salicylic Acid in Fruits.**

For the past twelve months or more tests for Salicylic acid in fruits have been carried on in the laboratory of the Montana Experiment Station with the result of showing its almost constant presence in extremely small quantity.

As far as we know the only similar work has been done by Portes and Desmouliere (Journal de Pharmacie et de Chimie, t. XIV, p. 106) who report its presence to the extent of a milligram to the kilogram of strawberries.

Desmouliere in his Doctorate Thesis in the Universite de Paris reports its presence in raspberries, mulberries and liquorice (Journal de Pharmacie et de Chimie, t. 16, p. 86). This so

far as we know covers all the work done outside this laboratory on fresh fruit.

It is probable that the acid is present as the methyl salt, which is well known in the oil of wintergreen, though we have not yet taken steps to prove this.

Among the fruits from which we have obtained the salicylic acid reaction are the following: strawberries, raspberries both red and black, blackberries, currants, plums, black cherries, apricots, peaches, Concord grapes, crab apples, standard apples, quinces and oranges.

In a few instances we have made this work quantitative with the following results:

Currants 0.57 mgms. acid per kilo of fruit.  
Cherries 0.46 mgms. acid per kilo of fruit.  
Plums 0.28 mgms. acid per kilo of fruit.  
Crab apples 0.24 mgms. acid per kilo of fruit.  
Grapes 0.32 mgms. acid per kilo of fruit.

These values, however, are not absolute but only comparative and represent the amount we have succeeded in extracting in each case. We distilled the fruit with phosphoric acid, extracted the distillate with ether, took up with a small amount of water and applied the ferric chloride test after the ether had evaporated. Check analyses were made with known amounts of salicylic acid and showed that not nearly all the acid was extracted by this method.

We have also found the salicylic acid reaction to be given by tomatoes, cauliflower and string beans.

It seems to us that the bearing of this work is very important, particularly as regards the investigations of food chemists. Even these very small quantities may not react to the tests for salicylic acid as usually applied, especially in view of the small amount of material generally worked upon, 25 grams, yet a knowledge of the wide spread distribution may save reporting on occasion materials as adulterated to which salicylic acid has not been added. Knowing that salicylic acid may occur in many of the substances examined, a quantitative determination will be necessary in each case or it will be well to report only on strong reactions.

We were led to this investigation by the protest of a well-known reputable firm in whose currant jelly we reported salicylic acid which was present in apparently no greater quantity than we have since found it in the fresh currants. A similar experience was recently had in one of the state laboratories for food control.

In addition to the above work we are also studying the distribution of benzoic acid in fruit and vegetables and hope to be able to publish our results within the year.

My thanks are especially due to Mr. Edmund Burke, assistant chemist, upon whom most of the analytical work fell, and also to Mr. Irvin Cockrill, who, while a post-graduate student, carried out the work upon the vinegars and baking powders.

Prato- No.	Name of Brand.	Name of Manufacturer.	Place of Manufacture.	Adulterant.
1609	Oval Brand String Beans.....	A. Booth Packing Co.....	Baltimore Md.....	Benzole acid.....
1611	Shield Brand String Beans....	J. S. Farren & Co.....	Baltimore Md.....	Salicylic Acid.. ..
CANNED BEANS NOT FOUND ADULTERATED.				
1581	Magnet Brand Stringless Beans..	Isaac Robinson.....	Baltimore, Md.....	
1588	Gopher Brand String Beans....	Foley Bros. & Kelley Mer. Co....	St. Paul, Minn.....	
1604	Jumbo Brand Stringless Beans..	Miller Bros. & Co.....	Baltimore Md.....	
1605	Peerless Brand String Beans....	The C. H. Pearson Packing Co....	Baltimore Md.....	
1608	Club House Brand String Beans.	Franklin MacVeagh & Co.....	Chicago, Ill.....	
CANNED PEAS NOT FOUND ADULTERATED.				
1519	Green Island Brand Peas.....	Green Island Packing Co.....	Green Bay, Wis.....	
1525	Monarch Brand Peas.....	Reid, Murdoch & Co.....	Chicago, Ill.....	
1523	Fort Snelling Brand Peas.....	Foley Bros. & Kelley Mer. Co....	St. Paul, Minn.....	
1606	Club House Brand Peas.....	Franklin MacVeagh & Co.....	Chicago, Ill.....	
1582	Petits Pois Extras Fins "Le Soleil Malines" (Peas).....	Fabrique International.....	France .....	
1583	Petits Pois Tres Fins (Peas)....	Delory .....	Lorient, France .....	
CANNED CORN NOT FOUND ADULTERATED.				
1259	Leopard Brand Corn.....	George R. Newell & Co.....	St. Paul, Minn.....	
1505	Diamond Brand Sugar Corn.....	Atlantic Canning Co.....	Atlantic, Iowa .....	
1523	Extra Sweet Corn.....	Reid, Murdoch & Co.....	Chicago, Ill.....	
1590	Seal Brand Standard Quality Corn	P. J. Ritter Conserve Co.....	Philadelphia, Pa.....	
1602	Fort Snelling Brand Corn .....	Foley Bros. & Kelley Mer. Co....	St. Paul, Minn.....	
1607	Club House Brand Extra Corn..	Franklin MacVeagh & Co.....	Chicago, Ill.....	
1615	Honey Drop Sugar Corn.....	Davis Baxter & Co.....	Portland, Me.....	

## SOUPS FOUND ADULTERATED.

Lab. No.	Name of Brand.	Name of Manufacturer.	Where Manufactured.	Preservative.
1348	Huckin's Terrapin Soup	J. H. W. Huckins & Co. . .	Boston, Mass.	Salicylic acid.
1586	Van Camp's Concentrated Vegetable Soup	The Van Camp Packing Co.	Indianapolis, Ind.	Salicylic acid.
1599	Van Camp's Concentrated Mock Turtle Soup	The Van Camp Packing Co.	Indianapolis, Ind.	Salicylic acid.
1600	Van Camp's Concentrated Ox Tail Soup	The Van Camp Packing Co.	Indianapolis, Ind.	Salicylic acid.
1613	Van Camp's Concentrated Tomato Soup	The Van Camp Packing Co.	Indianapolis, Ind.	Salicylic acid.

## SOUPS NOT FOUND ADULTERATED.

Lab. No.	Name of Brand.	Name of Manufacturer.	Where Manufactured.	Preservative.
1347	Huckin's Green Turtle Soup—White Label.	J. H. W. Huckins & Co.	Boston, Mass.	
1360	French Bouillon.	Armour Packing Co.	Kansas City, Mo.	
1361	Clam Broth	Franco-American Food Co.	New York	
1580	French Soup, Mutton	Franco-American Food Co.	New York	
1584	French Soup, Chicken	Franco-American Food Co.	New York	
1587	Van Camp's Concentrated Chicken Red Letter Double Concentrated	The Van Camp Packing Co.	Indianapolis, Ind.	
1601	Beef Soup	The Mullen-Blackledge Co.	Indianapolis, Ind.	
1612	Van Camp's Concentrated Bouillon	The Van Camp Packing Co.	Indianapolis, Ind.	
1359	White Label Clear Consomme.	Armour Packing Co.	Kansas City, Mo.	

No.		
1260	Casino Brand Tomatoes.....	Franklin MacVeagh & Co. Chicago, Ill. .... Salicylic acid.....
1262	Home Brand Tomatoes.....	Griggs, Cooper & Co. .... St. Paul, Minn. .... Salicylic acid.....
1263	Chicago Best Quality Guaranteed Tomatoes .....	Steele & Wedeles Co. .... Chicago, Ill. .... Salicylic acid.....
1485	Tremaine's Tomatoes .....	Reid, Murdoch & Co. .... Chicago, Ill. .... Salicylic acid.....

## CANNED TOMATOES NOT FOUND ADULTERATED.

1258	Wicomico Tomatoes.....	T. R. Jones .....	Quantico, Md .....
1261	Nonpareil Brand Tomatoes.....	Alameda Canning & Packing Co. ....	San Francisco, Cal. ....
1595	Charm Brand Tomatoes.....	Franklin MacVeagh & Co. ....	Chicago, Ill. ....
1596	Utah Brand Tomatoes.....	Craig Bros. ....	Ogden, Utah.....
1597	Red Knight Tomatoes.....	N. S. Martz .....	Arcadie, Ind.....
1598	Monumental Brand Tomatoes.....	W. W. Taylor & Son. ....	Baltimore, Md.....
1498	Ivy Leaf Brand Tomatoes.....	Thos. D. Miller .....	Weber, Ind.....

## ANALYSIS OF TOMATO CATSUPS.

Lab. No.	Name of Brand.	Name of Manufacturer.
1257	Snider's Home-made Catsup.....	T. A. Snider Preserve Co.....
1269	Priscilla .....	Franklin MacVeagh & Co .....
1363	Blue Label .....	Curtice Brothers Co.....
1365	Tart Tomato Catsup, Standard Brand .....	P. J. Ritter Conserve Co.....
1366	Favorite Brand Tomato Catsup..	P. J. Ritter Conserve Co.....
1367	Shrewsbury Puree of Tomatoes..	E. C. Hazard & Co.....
1368	Eagle Brand Tomato Ketchup..	Kuner Pickle Co.....
1559	Sunny Side Ketchup .....	The Tip Top Ketchup Co.....
1507	Extra Tomato Catsup Monarch Brand .....	Reid, Murdoch & Co.....
1558	Standard Tomato Catsup .....	Standard Packing Co.....
1508	Bayle's Tomato Catsup.....	Geo. A. Bayle.....
1494	Sweet Spiced .....	Gordon & Dilworth .....
1746	Old Virginia Ketchup.....	Geo. K. McMechen & Son Co..
1977	Nail City Catsup .....	The West Vir. Preserving Co..
1979	Heinz Tomato Ketchup.....	H. J. Heinz Co.....

## ANALYSIS OF TOMATO CATSUPS.

Where Manufactured.	Preservative	Coloring Matter
Cincinnati, O.....	Benzoic acid .....	Coal Tar Dye ...
Chicago, Ill. ....	Salicylic acid.....	Coal Tar Dye ...
Easton, N. Y.....	Salicylic acid.....	Coal Tar Dye ...
Philadelphia, Pa.....	Benzoic acid .....	.....
Philadelphia, Pa.....	Salicylic acid.....	Coal Tar Dye...
Swinsbury, N. J.....	Salicylic Acid.....	Coal Tar Dye ..
Denver, Col.....	Salicylic acid.....	Coal Tar Dye ..
Chicago, Ill. ....	Benzoic acid .....	Coal Tar Dye ..
Cincinnati, O.....	Acid Sulphite .....	Coal Tar Dye ..
St. Louis, Mo.....	Salicylic acid.....	Coal Tar Dye ..
St. Louis, Mo.....	Acid Sulphite .....	.....
New York, N.Y. ....	Benzoic acid .....	Coal Tar Dye ..
Richmond, W. Va.....	Sulphite .....	Coal Tar Dye ..
.....	Sal'c acid and Sulphite.....	Coal Tar Dye ..
Pittsburg, Pa.....	Benzoic acid .....	.....

## JAMS, JELLIES, AND PRESERVES, ALL ADULTERATED.

Lab. No.	Name of Brand.	Name of Manufacturer.
1265	Eagle Jam, Grape Compound....	Anderson Preserving Co.....
1266	Eagle Jam, Pineapple Compound.	Anderson Preserving Co.....
1268	Eagle Jam, Raspberry Compound	Anderson Preserving Co.....
1481	Queen Black Raspberry Jam....	Franklin MacVeagh & Co.....
1482	Queen Blackberry Jam.....	Franklin MacVeagh & Co.....
1483	Queen Strawberry Jam.....	Franklin MacVeagh & Co.....
1486	Queen Red Raspberry Jam.....	Franklin MacVeagh & Co.....
1487	Queen Apricot Jam.....	Franklin MacVeagh & Co.....
1488	Queen Green Gage Jam.....	Franklin MacVeagh & Co.....
1489	Queen Currant Jam.....	Franklin MacVeagh & Co.....
1490	Queen Cherry Jam.....	Franklin MacVeagh & Co.....
1491	Queen Peach Jam.....	Franklin MacVeagh & Co.....
1495	Queen Pineapple Jam.....	Franklin MacVeagh & Co.....
1496	Queen Gooseberry Jam.....	Franklin MacVeagh & Co.....
1497	Queen Pear Jam.....	Franklin MacVeagh & Co.....
1522	Extra Grated Pineapple.....	Reid, Murdoch & Co.....
1552	Pure Fruit Jam, Blackberry....	Reid, Murdoch & Co.....
1553	Genesee Fresh Fruit Jam, Currant	Batavia Preserving Co.....
1585	Gopher Brand Preserved Straw- berries.....	Foley Bros. & Kelly Mer. Co....
1615	D. & B. Brand, Extra Quality, Raspberry Preserves.....	Dodson-Brown Mfg. Co.....
1616	D. & B. Brand Strawberry Pre- serves.....	Dodson-Brown Mfg. Co.....
1617	*Red Currant Jelly.....	Gordon & Dilworth.....
1618	Extra Quality Blackberry Jelly..	Philip J. Ritter Conserve Co....
1619	Extra Quality Currant Jelly....	Philip J. Ritter Conserve Co....
1620	Favorite Brand Compound Cur- rant Jelly.....	Philip J. Ritter Conserve Co....
1621	Favorite Brand Compound Straw- berry Jelly Flavor.....	Philip J. Ritter Conserve Co....
2274	Peacock Brand Peach Jam.....	Franklin MacVeagh & Co.....
2275	Peacock Brand Blackberry Jam..	Franklin MacVeagh & Co.....
2276	Peacock Brand Cherry Jam.....	Franklin MacVeagh & Co.....
2277	Peacock Brand Pineapple Jam..	Franklin MacVeagh & Co.....
2278	Peacock Brand Quince Jam....	Franklin MacVeagh & Co.....
2279	Peacock Brand Black Raspberry Jam.....	Franklin MacVeagh & Co.....
2280	Peacock Brand Red Raspberry Jam.....	Franklin MacVeagh & Co.....
2281	Peacock Brand Apricot Brand..	Franklin MacVeagh & Co.....

\*Contains only a small quantity of Salicylic acid which subsequent investigations have shown was probably normally present in the fresh fruit used and which could not be considered an adulterant.

Where Manufactured.	Preservative.	Coloring Matter.	Other Adulterants
nden, N. J....	Salicylic acid	Coal Tar Dye...	starch Paste and Glucose
nden, N. J....	Salicylic acid.	.....	Starch Paste and Glucose.
nden, N. J....	Salicylic acid.	Coal Tar Dye...	Starch Paste and Glucose,
cago, Ill.....	Salicylic acid.	.....	Glucose .....
cago, Ill.....	Salicylic acid.	Coal Tar Dye...	Glucose .....
cago, Ill.....	Salicylic acid.	.....	Starch Paste and Glucose.
cago, Ill.....	Salicylic acid.	Coal Tar Dye...	Starch Paste and Glucose.
cago, Ill.....	Salicylic acid.	.....	Glucose .....
cago, Ill.....	Salicylic acid.	.....	Glucose .....
cago, Ill.....	Salicylic acid.	.....	Starch Paste and Glucose.
cago, Ill.....	Salicylic acid.	.....	Glucose .....
cago, Ill.....	Salicylic acid.	.....	Glucose .....
cago, Ill.....	Salicylic acid.	.....	Glucose .....
cago, Ill.....	Salicylic acid.	.....	Glucose .....
cago, Ill.....	Salicylic acid.	.....	Glucose .....
cago, Ill.....	Salicylic acid.	.....	Starch Paste and Glucose.
cago, Ill.....	Salicylic acid.	.....	.....
nesee Co. N. Y	Salicylic acid	Coal Tar Dye...	.....
Paul, Minn..	Salicylic acid	.....	.....
Louis, Mo...	Salicylic acid	.....	.....
Louis, Mo...	Salicylic acid.	.....	.....
w York.....	Salicylic acid.	.....	.....
ladelphia.....	Salicylic acid.	.....	.....
ladelphia.....	Salicylic acid.	.....	.....
ladelphia.....	Salicylic acid.	.....	.....
ladelphia.....	Salicylic acid.	.....	.....
cago, Ill.....	Sulphite.....	.....	Starch Paste.....
cago, Ill.....	Salicylic acid	.....	Starch Paste.....
cago, Ill.....	and Sulphite..	.....	Starch Paste.....
cago, Ill.....	Sulphite.....	Coal Tar Dye...	Starch Paste.....
cago, Ill.....	Sulphite.....	.....	Starch Paste.....
cago, Ill.....	Sulphite.....	.....	Starch Paste.....
cago, Ill.....	Sulphite and..	Coal Tar Dye...	Starch Paste.....
cago, Ill.....	Salicylic acid..	.....	.....
cago, Ill.....	Sulphite.....	Coal Tar Dye...	Starch Paste.....
cago, Ill.....	Sulphite.....	.....	.....

## ANALYSIS OF CEREAL BREAKFAST FOODS.

Lab'y No.	Name of Article and by Whom Manufactured.	Per Cent Water	Per Cent Nitrogen	Crude Protein Per Cent	Per Cent Ash
1537	Oat Meal Wafers, Nebraska Sanitarium	5.35	1.56	9.72	1.16
1538	Graham Crackers, Neb. Sanitarium	5.11	1.79	11.19	1.31
1539	Whole Wheat Wafers, Neb. Sanitarium	5.91	1.78	11.13	1.19
1540	Oat Meal Crackers, Neb. Sanitarium	4.84	1.84	11.50	1.22
1541	Granose Biscuit, Battle Creek Sanitarium	6.96	1.86	11.63	2.36
1542	Zwieback, Battle Creek Sanitarium	6.66	1.92	11.90	1.49
1543	Cream Shortened Sticks, Battle Creek Sanitarium	5.30	1.53	9.56	1.09
1544	Pillsbury's Vitos, Pillsbury-Washburn Flour Mills Co., Minn.	6.29	2.07	12.94	.94
1577	Oat Meal, Bozeman Milling Co., Mfg. by Sioux Milling Co., Sioux City, Iowa.	7.16	2.51	15.69	1.85
1527	Rolled Avena, The American Cereal Co., F. Schumacher Mills, Akron, Ohio.	6.64	2.36	14.75	2.16
1528	Rolled White Pure Quaker Oats, American Cereal Co., Chicago, Ill.	6.66	2.27	14.19	1.86
1532	Hornby's Oat Meal, The H.-O. Co., Clover Mills, Buffalo, N. Y.	8.31	2.39	14.94	1.84
1534	Buckeye Rolled Oats, American Cereal Co., Chicago, Ill.	6.83	2.27	14.19	1.97
1576	White Corn Meal, Sioux Milling Co., Sioux City, Iowa.	10.21	1.22	7.63	.73
1526	Granose Flakes, Battle Creek Sanitarium	10.08	2.33	15.66	3.35
1529	Wheat Gluten, Battle Creek Sanitarium	5.25	2.71	18.95	.97
1531	Wheatena, Health Food Co., New York City	6.55	2.21	13.81	1.81
1535	Shredded Whole Wheat Biscuit, The Shredded Wheat Co., Worcester, Mass.	6.25	1.79	11.18	1.66
1559	Granola, Sanitarium Bakery, College View, Nebraska.	4.95	2.31	14.44	1.72
1560	Ralston Health Club Barley Food, Purina Mills, St. Louis, Mo.	7.32	2.01	12.56	1.62
1561	Grape Nuts, Postum Cereal Co., Battle Creek, Mich.	3.62	1.89	11.81	2.07
1562	Cracked Wheat, American Cereal Co., Chicago, Ill.	7.38	1.48	9.25	1.87
1563	Flaked Oat Food, Pillsbury-Washburn Co., Minneapolis, Minn.	4.94	2.30	14.38	2.02
1564	Granut, Battle Creek Sanitarium	5.14	1.46	9.13	.24
1565	Pettibone's Breakfast Food, American Cereal Co., Chicago, Ill.	7.51	1.70	10.65	1.87
1567	Rice Flakes, Lauchhoff Bros., Detroit, Mich.	6.48	1.26	7.88	.47
1568	Wheatine, Empire Milling Co., San Francisco, Cal.	7.92	1.65	10.31	1.84
1569	Cream of Wheat, Cream of Wheat Co., Minneapolis, Minn.	8.10	1.87	11.69	.56
1570	Slough Wheat Flakes, Slough Milling Co., Sioux City, Iowa.	8.60	1.87	12.02	.52

Lab'y No.	Name of Brand.	Name of Manufacturer.	Where Manufactured.	Filler	Available Carbonic Acid Gas	*Volume Carbonic Acid Gas	Value Terms cts per lb.	Price per pound
1273	Schilling's Best.	A. Schilling & Co.	San Francisco, Cal.	None	14.65	163.5	.40	.40
1274	Price's Cream	Price Baking Powder Co.	Chicago, Ill.	Starch.	13.70	155.5	.37	.....
1272	Golden Gate	S. A. Folger & Co.	San Francisco, Cal.	None	12.84	150.4	.35	.....
1650	Royal	Royal Baking Powder Co.	New York City, N. Y.	Starch.	12.63	142.4	.34	.....
1651	Club House	Franklin MacVeagh & Co.	Chicago, Ill.	Starch.	9.55	107.7	.26	.....
1652	Monarch	Reld, Murdoch & Co.	Chicago, Ill.	Starch.	11.16	125.8	.30	.35

## ALUM POWDERS

1653	Home	Home Baking Powder Co.	San Francisco, Cal.	Starch.	7.75	87.0	.....	.16
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## ALUM-PHOSPHATE POWDERS.

1654	Calumet	Cal. Baking Powder Co.	Chicago, Ill.	Starch.	11.29	127.25	.....	.35
1656	Chapman	Chapman & Smith Co.	Chicago, Ill.	Starch.	7.25	83.9	.....	.....
1666	K. C.	Jacques Manufacturing Co.	Chicago, Kansas City, O.	Starch.	9.58	107.9	.....	.16
1657	Mountain Top	Courtney & Co.	Butte, Mont.	Starch.	6.55	73.9	.....	.....
1658	Palace	McCormick, Behnke & Co.	St. Paul, Minn.	Starch.	6.27	69.6	.....	.....
1660	Perfect	Perfect Baking Powder Co.	St. Louis, Mo.	Starch.	5.41	61.	.....	.....
1661	Silver Queen	A. Booth	Butte, Mont.	Starch.	4.15	46.8	.....	.....

## PHOSPHATE AND SULPHATE POWDERS.

1662	Snowdrift	R. C. Wallace & Co.	Helena, Mont.	Starch.	11.13	127.5	.....	.....
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\*Volume of gas liberated from one ounce of baking powder calculated to the normal pressure existing at Bozeman and to the temperature of 70 degrees Fahrenheit.

TABLE OF FLOUR ANALYSIS.

Lab'y No.	Brand.	Miller and Town.	Moisture.	Nitrogen per cent.	Crude Protein per cent
1174	XXXX	Big Timber M. Co. B. T.	9.55	1.72	16.75
1173	Royal	Bozeman M. Co., Bozeman.	10.05	1.92	12.90
97	Economy	Bozeman M. Co., Bozeman.	10.00	1.55	9.69
102	Ceretana	Bozeman M. Co., Bozeman.	10.03	2.38	14.87
100	Pillsbury's Best	Pillsbury Washburn Co., Minneapolis	9.05	2.20	13.75
98	Saskatchewan	N. Story & Co., Bozeman.	10.28	2.00	12.50
99	Montana Belle	N. Story & Co., Bozeman.	10.31	1.60	10.00
113	Occidental	Bozeman Milling Co.	10.00	2.48	15.50
114	Ceretana	Bozeman Milling Co.	10.51	2.14	13.38
115	Gilt Edge	Bozeman Milling Co.	10.17	2.42	16.13
116	Electric Light	Bozeman Milling Co.	10.21	2.37	14.81
117	Choice.	Bozeman Milling Co.	10.35	2.35	14.69
119	Royal	Bozeman Milling Co.	10.11	2.50	16.63
120	Best	Bozeman Milling Co.	9.75	2.14	13.34
1612	Sun Fancy Patent.	Bonner Milling Co., Bonner, Mont.	10.94	1.70	10.63
1613	Star Clear	Bonner Milling Co., Bonner, Mont.	10.68	1.76	11.00
1616	Rose Straight	Bonner Milling Co., Bonner, Mont.	11.38	1.81	11.31
1575	Whole Wheat Flour.	Bozeman Milling Co.	9.56	1.41	8.81

Lab'y No.	Name of Brand.	Name of Manufacturer.	Where Manufactured.	Preservative.
1267	Rex Pork and Beans with Tomato Sauce	Cudahy Canning Co.	South Omaha, Neb.	Salicylic
1358	Heinz's Baked Beans with Tomato Sauce	H. J. Heinz & Co.	Pittsburg, Pa.	Salicylic
1493	Monarch Tomato Picnic Sauce	Reid, Murdoch & Co.	Chicago, Ill.	Salicylic
1521	Baked Beans	H. J. Heinz & Co.	Pittsburg, U. S. A.	Salicylic
	Choice Selected Beans with Tomato Sauce	Franklin, MacVeagh & Co	Chicago, Ill.	Salicylic
1364	Club House Brand Baked Beans	Grocers Packing Co.	Boston, Mass.	Salicylic
1362	Boston Baked Beans			

## BAKED BEANS NOT FOUND ADULTERATED.

1484	Pork and Beans	Franklin MacVeagh & Co.	Chicago, Ill.
1501	Sanitarium Brand Nut Seasoned Baked Beans with Tomato Sauce	Sanitarium Health Food Co.	Battle Creek, Mich.
1502	Sanitarium Brand Nut Seasoned Baked Beans with Tomato Sauce	Sanitarium Health Food Co.	Battle Creek, Mich.

## ANALYSIS OF VINEGARS.

Lab'y No.	Manufacturer.	Place of Manufacture,	Selling Price Per Gal.	Sulphates	Chlorides	Coloring Matter
1623	F. C. Johnson.....	Kishwaukee, Ill..	\$.50	None.	None.	None....
1624	F. C. Johnson.....	Kishwaukee, Ill..	.50	Trace	None.	None....
1625	F. C. Johnson.....	Kishwaukee, Ill..	.50	None.	Trace	None....
1626	F. C. Johnson.....	Kishwaukee, Ill..	.50	Trace	None.	None....
1627	H. J. Heinz & Co.....	Pittsburg, Pa....	.60	Trace	Trace	None....
1628	Smith Refining Works..	Council Bluffs, Ia	.40	None.	None.	Caramel.
1629	Smith Refining Works..	Council Bluffs, Ia	.35	None.	None.	Caramel.
1630	A. Steinhorst.....	Kansas City, Kas	*	Trace	None.	Caramel.
1631	Could not obtain.....	Did not know ...	.40	None.	None.	Caramel.
1632	Sour Cider.....	Helena..Mont. ...	.40	None.	None.	None....
1633	Cross & Blackwell....	Vienna and Phila	1.80	Trace	None.	Caramel.
1634	Wallace & Gregory Bros.	Paducah,Ky. ....	.60	None.	None.	Caramel.
1635	Wallace & Gregory Bros.	Paducah,Ky. ....	.40	None.	None.	Caramel.
1636	Wallace & Gregory Bros.	Paducah,Ky. ....	.40	None.	None.	Caramel.
1637	Wallace & Gregory Bros.	Paducah,Ky. ....	.80	None.	None.	Caramel.
1638	Wallace & Gregory Bros.	Paducah,Ky. ....	.50	Trace	None.	Caramel.
1639	Wallace & Gregory Bros.	Paducah,Ky. ....	.40	None.	None.	Caramel.
1640	Wallace & Gregory Bros.	Paducah,Ky. ....	.35	None.	None.	Caramel.
1641	Wallace & Gregory Bros.	Paducah,Ky. ....	.....	Trace	None.	Caramel.
1642	Wallace & Gregory Bros.	Paducah,Ky. ....	.50	Trace	Trace	Caramel.
1643	Wallace & Gregory Bros.	Paducah,Ky. ....	.60	Trace	None.	Caramel.
1644	Wallace & Gregory Bros.	Paducah,Ky. ....	.40	None.	None.	Caramel.
1645	Wallace & Gregory Bros.	Paducah,Ky. ....	.35	None.	None.	Caramel.
1646	Wallace & Gregory Bros.	Paducah,Ky. ....	.....	None.	None.	None....
1647	Wallace & Gregory Bros.	Paducah,Ky. ....	.....	None.	None.	None....
1648	F. C. Johnson.....	Kishwaukee, Ill..	.....	None.	None.	None....
1649	Wallace & Gregory Bros. (Sample Jugs).....	Paducah,Ky. ....	.....	Trace	None.	None....

\*Refused.

## ANALYSIS OF VINEGARS.

Per Cent Ash	Ash Alk. or Neut.	Flame.	Sold as—	Per cent Acetic Acid.	Remarks.
.258	Alk.	Pot.....	Cider Vin.....	5.55	Is an apple cider vinegar.....
.46	Alk.	Pot.....	Ap. Cider Vin.	5.15	Is an apple cider vinegar.....
.26	Alk.	Pot.....	Cider Vin.....	3.20	Is diluted apple cider vinegar.
.44	Alk.	Pot.....	Cider Vin.....	5.55	Is an apple cider vinegar.....
.039	Alk.	Pot. & Sod.	Pickling Vin..	5.45	Is a malt vinegar.....
.021	Alk.	Pot. & Sod.	Common Vin	8.00	Probably an acid vinegar.....
.052	Alk.	Pot. & Sod.	Weakened Vin	4.75	Probably an acid vinegar.....
.065	Alk.	Pot. & Sod.	Cider Vin.....	6.50	Probably a malt vinegar.....
.055	Alk.	Pot. & Sod.	Cider Vin.....	3.67	Probably a malt vinegar.....
.46	Alk.	Pot.....	Not Sold.....	1.40	An apple cider vinegar.....
.28	Alk.	Pot. & Sod.	Malt.....	4.95	Sold in qt. bot. pure malt vin.
.035	Alk.	Pot. & Sod.	Cider Vin.....	7.88	Without doubt a malt vinegar.
.038	Alk.	Pot. & Sod.	Cider Vin.....	2.35	Without doubt a malt vinegar.
.063	Alk.	Pot. & Sod.	Cider Vin.....	4.90	Without doubt a malt vinegar.
.068	Alk.	Pot. & Sod.	Cider Vin.....	9.00	Without doubt a malt vinegar.
.075	Alk.	Pot. & Sod.	Cider Vin.....	5.20	Without doubt a malt vinegar.
.018	Alk.	Pot. & Sod.	Cider Vin.....	7.25	Without doubt a malt vinegar.
.014	Alk.	Pot. & Sod.	Cider Vin.....	4.47	Without doubt a malt vinegar.
.23	Alk.	Pot. & Sod.	Cider Vin.....	4.70	Without doubt a malt vinegar.
.29	Alk.	Pot. & Sod.	Cider Vin.....	3.82	Without doubt a malt vinegar.
.054	Alk.	Pot. & Sod.	Ap. Cider Vini	4.47	Without doubt a malt vinegar.
.029	Alk.	Pot. & Sod.	Ap. Cider Vini	4.65	Without doubt a malt vinegar.
.021	Alk.	Pot. & Sod.	Ap. Cider Vini	5.20	Without doubt a malt vinegar.
.017	Alk.	Pot. & Sod.	White Wine V.	8.90	Probably made from glucose..
.027	Alk.	Pot. & Sod.	White Wine V.	4.12	Probably made from glucose..
.50	Alk.	Pot.....	Ap. Cider Vini	5.62	An apple cider vinegar.....
.32	Alk.	Pot.....	Ap. Cider Vini	4.62	An apple cider vinegar.

## MISCELLANEOUS FOODS FOUND ADULTERATED.

Name of Brand.	Name of Manufacturer.	Where Manufact'd	Preservative.
1316 Veal Loaf	Libby, McNeil & Libby.	Chicago, Ill.	Boric Acid
1317 Durkee's Salad Dressing.	E. R. Durkee & Co.	New York	Salicylic
1318 Devilled Crab	Tangler Packing Co.	Crisfield, Md.	Boric Acid
1319 Devilled Ham	Underwood Co.	Boston, Mass.	Boric Acid
1350 Canned Corned Beef	Libby, McNeil & Co.	Chicago, Ill.	Boric Acid
1436 Gold Brand Sweet Potatoes.	Batesville Canning Co.	Batesville, Miss.	Salicylic
1499 Breck's Grape Juice	F. A. Breck.	Vineand, N. J.	Salicylic
1594 Monarch Brand, Extra Salmon.	Reid, Murdoch & Co.	Chicago, Ill.	Boric Acid

## MISCELLANEOUS FOODS NOT FOUND ADULTERATED.

1264 Oysters, Best Quality	Steele-Wedeles Co.	Chicago, Ill.	
1349 Yacht Club Salad Dressing	Hildesley & Co.	Chicago, Ill.	
1492 Eagle Condensed Minced Meat.	Franklin, MacVeagh & Co.	Chicago, Ill.	
1500 Unfermented Grape Juice.	Sanitarium Health Food Co.	Battle Creek, Mich.	
1510 Pioneer Brand, Minced Sea Clam	Sea Beach Pickling Works.	Warrenton, Oregon.	
1520 Nuttose.	Sanitas Nut Food Co, Ltd.	Battle Creek, Mich.	
1524 Monarch Brand Extra Oysters.	Reid, Murdoch & Co.	Chicago, Ill.	
1589 Gopher Brand Extra Selected Suc- cotash.	Foley Bros. & Kelley Mer. Co.	St. Paul, Minn.	
1591 Club House Brand Extra Select- ed Oysters	Franklin, MacVeagh & Co.	Chicago, Ill.	

4  
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**BULLETIN No. 39.**

**MONTANA AGRICULTURAL**

**Experiment Station,**

**OF THE**

**Agricultural College of Montana.**

**Sheep Feeding in Montana.**

**Bozeman, Montana, November, 1902.**

**REPUBLICAN,  
Bozeman, Montana,  
1902.**

# MONTANA AGRICULTURAL EXPERIMENT STATION

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MONTANA EXPERIMENT STATION,

Bozeman, Montana.

**Notice.**—The Bulletins of the Station will be mailed free to any citizen  
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# Montana Experiment Station.

BULLETIN NO. 39.

NOVEMBER, 1902.

## Sheep Feeding in Montana.

By R. S. SHAW.

The agricultural conditions in Montana have now reached that stage of development whereby the state can rival the greatest feeding states of the Union, for within our own borders are to be found the sheep, hay, grain, water, climatic conditions, and men of enterprise to develop the industry. Montana now leads the states of the Union in numbers of sheep, the census of 1900 reporting 6,170,483 within her borders. Valleys, which ten years ago produced little or no hay, except some timothy or wild hay, are to-day furnishing thousands upon thousands of tons of legumes, especially suited to the fattening of sheep. The climatic conditions are such as to render the fattening process rapid and economical. Sufficient grain can be produced to give the meat products a good finish. The feasibility of shipping these finished products to the great markets has been successfully demonstrated.

### Suitability of Range Types of Sheep for Fattening.

The range sheep was bred primarily for wool production, though during later years an attempt has been made to improve their mutton qualities. These attempts at improvement along the latter line will no doubt result in the establishment of a dual purpose sheep, probably through the use of Rambouillet or Delaine rams on the native stock. Experience has already taught many of our sheepmen that the heavy mutton breeds, such as the Downs, will not answer on the range. Because, therefore, of the peculiar range conditions our feeders will have to be content with a dual type of sheep rather than a special mutton type for feeding. Tests have shown that there is little difference in the returns secured from the two types. Recent experiments at this Station showed that where the mutton type lambs produced 100 pounds increase in live weight at a cost of \$4.39, requiring 8.74 pounds of food to produce a pound of gain, those of the dual purpose or range type produced 100 pounds increase at a cost of \$4.62, requiring 9.0 pounds of food per pound gain. These figures show the range sheep to be not far behind the special type in mutton production, while they excel them in wool production under range conditions.

### Profits from Sheep Feeding.

In Station tests of 1900, 11.8 pounds of clover were required to maintain a sheep and produce one pound of gain. At this rate one ton of clover produced 169.5 pounds of mutton worth \$4.68 per cwt. This gave a return of \$7.93 per ton of the clover fed, while the local price was only \$5.00 per ton in the stack. In 1900 the net profits per head from the Station fed lambs was 81 cents, when clover was valued at \$6.00 per ton, oats at 90 cents per cwt. and damaged wheat at 40 cents per cwt. In 1901 a carload of Station lambs fed in five divisions on different rations, hence lacking in uniformity, netted a profit of 30 cents per head in Chicago when placed on the extremely poor market of March 1901. In this case clover was valued at \$5.00 per ton, grain 85 cents per cwt., and screenings at 55 cents per cwt. In 1902 Station fatter sheep gave the following profits on the Chicago market:

55 lambs, net profit of \$95.15, or \$1.73 per head.

51 one-year wethers, net profit of \$71.70, or \$1.40 per head.

52 two-year wethers, net profit of \$83.44, or \$1.57 per head.

53 aged ewes, net profit of \$1.00, or 1.8 cts. per head.

Clover was valued at \$5.00 per ton and grain at 90 cents per cwt.

### Cost of Producing Mutton in Montana.

Where legumes are used phenomenal results have been secured as regards amount of food required to produce a pound of mutton and the cost of the same. In Station tests of 1900, 6.38 pounds of clover and 2.8 pounds of wheat produced a pound of mutton at 3.22 cents, with clover worth \$6.00 per ton and damaged wheat 40 cents per cwt. At the same time 11.8 pounds of clover produced a pound gain, costing 3.54 cents, and 6.10 pounds of clover and 2.65 pounds of oats produced a pound of gain, costing 4.39 cents, oats being worth 90 cents per cwt. Station tests of 1901 gave the following results:

Cost per 100 pounds increase from clover, barley and oats, \$4.34.

Cost per 100 pounds increase from clover and screenings, \$3.34.

Cost per 100 pounds increase from clover alone, \$3.53.

In Station tests, 1902, one pound increase was produced at the following cost with sheep of different ages, viz.: Lambs 4.18 cents, one-year wethers 5.83 cents, two-year wethers 5.90 cents, and aged ewes 6.78 cents; clover was worth \$5.00 per ton and grain 90 cents per cwt.

As the prices charged for foods are far above the cost price, a secondary profit is secured from all the foods fed. These prices are far in excess of those charged for feed in eastern trials, where cheap grains are secured.

### Shipping vs. Local Markets.

The individual feeder should never rely on local markets. Their consuming capacity is so small that much difficulty is experienced in disposing of even less than a carload lot. In March, 1900, when lambs were worth \$6.50 to \$7.00 per cwt. in Chicago, a portion of a carload of Station lambs had to be disposed of at \$4.68 per cwt. on a local

market. The profits of 1901 and 1902 given above were secured, the former on the poorest and the latter on the best market for some years. The feeder should always select sheep in even carload lots with a view of shipping.

### Cost of Shipping.

Fat sheep and cattle have both been shipped from the Gallatin Valley to eastern and western markets, the cost being about the same in both cases.

In 1901 the cost of marketing lambs shipped from Bozeman to Chicago, a distance of about 1,400 miles, including all expenses, was 83 cents per head.

In 1902 the following expenses were incurred in marketing sheep of different ages, viz: lambs 78 cents, one-year wethers \$1.07, two-year wethers \$1.27 and aged ewes 94 cents, the whole lot averaging \$1.01 per head. In this latter case the cost is a little high owing to a prolonged stop-over.

### Shrinkage in Marketing.

In 1901 the shrinkage of Station lambs between Bozeman and Chicago was eight pounds each. Over the same route in 1902 lambs shrunk 7.6 pounds, or 8.7 per cent. One-year wethers shrunk 10.4 pounds, or 8.7 per cent, two-year wethers shrunk 12 pounds, or 8.5 per cent, and aged ewes shrunk 12.2 pounds, or 11.3 per cent. In both cases the sheep were fed in the morning with access to water and weighed between 2 and 3 o'clock p. m. before shipping in the evening.

### Method of Feeding and Equipment.

The beginner should start with not more than one or two carloads until every feature of the business becomes familiar. Except in careful hands the large enterprise undertaken suddenly, without proper equipment, is likely to result in failure.

### Equipment.

Small yards or enclosures are very essential. Sheep will not fatten well when allowed too much liberty to roam at will. The size of feeding yards will have to be determined by the extent of the feeding. In general the fewer sheep that are run together the better the results. The average farmer, who probably will not attempt to feed to exceed 2,000 per year, should figure on dividing these up in three or four lots, grading them according to size, condition and strength. The rations can then be so adjusted as to turn out the whole band in uniform condition of fatness. It is very essential to select high, dry feed yards, through which running water passes near one end if possible. Some kind of wire netting makes good fencing, with a few strands of barbed wire encircling the top of the outer enclosure to prevent the access of dogs or wild animals. Some form of shelter should be provided, though the same may not be used more than a few days throughout the entire season. On the Station farm a shed 16x64 feet was found to be sufficient to provide shelter for 220 sheep, giving each about five square feet of ground space. The shed is eight feet high on one side and six on the other; it is enclosed with rough lumber and covered with an under layer of brush and an upper one of straw. Such a structure provides suitable protection except in time of rain in the late spring.

A suitable form of hay rack is very essential. Those used at the Station in the past few years have given excellent results. They are 16 feet long,  $3\frac{1}{2}$  feet high and 3 feet wide. The bottom board is 12 inches and the feeding space above is 8 inches in width. Above the feeding space three 1x6 inch boards are used. A rack of this style will furnish feeding space for thirty lambs.

### Feeding.

HAY should not be supplied more than twice each day, and once may be preferable, furnishing only that amount which will be well cleaned up. In case of very coarse fodder the rough leavings should be removed; if forced to consume them the gains of the sheep will be reduced. Feeding on the ground is wasteful and unsatisfactory.

**GRAIN.** Only a light grain ration is necessary to produce a finish with the legumes available; from one-half to three-quarters a pound of grain per head per day, along with alfalfa or clover, be sufficient to give the desired finish, if fed throughout a period extending from seventy to ninety days. The grain ration should be extended throughout the whole feeding period rather than the half, as has been practiced in some localities. The grain may be supplied in troughs fastened to the posts enclosing each feed lot. U-shaped troughs are desirable to prevent sheep from jumping up and standing in them. Unground grain will answer well for sheep with sound teeth.

**SALT.** Should be in constant supply so that the sheep can have it at will.

### Gleaning Grain Fields.

The cheapest and most rapid gains are secured from sheep running on grain and clover stubble after harvest and before the grazing season begins. In 1901 225 lambs which pastured on 112 acres of the Station farm for thirty days before going on feed, made an average increase in live weight of 9.78 pounds. The most profitable way of fattening aged ewes is by running them on clover and grain stubble during the entire autumn season.

### Comparative Feeding Value of Alfalfa, Red and Alsike Clover

MONTANA STATION BULLETIN No. 21.

The sheep feeding industry of Montana is based on the production of legumes. Almost without exception every valley in the state, possessing of water supplies for irrigation, can be made to grow one or more of the legumes mentioned, depending upon the peculiarity of the soil, and soil moisture conditions. Some portions of the state, and the Yellowstone valley, are pre-eminently suited to the growth of alfalfa, while in others, such as the Gallatin, conditions well suited to the growth of the three legumes are found in various sections. Because of the fact that these three crops are coming into common use a test was made to

determine their relative values, with the following result, as reported in Bulletin No. 21.

Composition of the legumes used, furnished from analyses by Dr. W. W. Traphagen, Station Chemist.

	ALSIKE PER CENT.	RED CLOVER PER CENT.	ALFALFA PER CENT.
Water.....	6.05	5.16	5.09
Crude Protein.....	13	12.37	12.37
Other Extract.....	3.07	5.29	4.07
Free Extract.....	38.71	45.84	39.82
Crude Fibre.....	29.45	22.65	31.10
ash.....	9.72	7.55	8.79

The comparative data secured were as follows:

16 lambs receiving alsike gained 405 pounds in 84 days.

16 lambs receiving red clover gained 402 pounds in 84 days

16 lambs receiving alfalfa gained 377 pounds in 84 days.

---

Alsike clover consumed per pound increase, 6.32 lbs.

Red clover consumed per pound increase 6.43 lbs.

Alfalfa consumed per pound increase 6.58 lbs.

In this test both grain and root rations were fed along with the legumes, in like manner and amount. The results are in keeping with the protein content of the food stuffs, alsike being the highest by .63 of one per cent. In those cases where similar tests have been made in other states alfalfa has been reported about 2 per cent higher in protein contents than the clover. We conclude from this test that the feeding values of the three legumes are little different because of the greater yields obtained from the alfalfa, as compared with the clovers. The percentage of waste resulting from coarse inedible stems was least from the alsike and greatest from the alfalfa.

### Fattening Lambs on Clover with and without Grain.

MONTANA STATION BULLETIN No. 27.

Three lots of twenty lambs each were fed for ninety days, one on

clover only, the second on clover and wheat, and the third on wheat and oats. Clover was worth \$6.00 per ton, damaged wheat 4 cwt. and oats 90c. per cwt. The damaged wheat was used in order to compare the financial result from expensive and inexpensive rations. The results were as follows:

Gain per head per month from feeding clover and wheat,	10 p
Gain " " " " " " " " only,	8.1 p
Gain " " " " " " " " and oats,	10.58 p

---

Food required per pound gain with clover and wheat, clover 6.1  
wheat 2.1

Food required per pound gain with clover only, clover 11.1

Food required per pound gain with clover and oats, clover 6.1  
oats 2.1

---

Cost per 100 pounds increase from feeding clover and wheat, \$3.22.

Cost per 100 pounds increase from feeding clover only,

Cost per 100 pounds increase from feeding clover and oats,

The conclusions drawn were: (1) That unmarketable grain fed to sheep along with clover produces good gains at low cost. That while fairly good gains can be secured from feeding large amounts of clover alone, some grain is required to impart a good finish for marketing. (3) High priced marketable grains render the cost of production too great without increasing the live weight sufficiently to justify their use. (4) Light grain rations are sufficient where legumes are fed. In both instances quoted above only .93 lbs. grain was fed per head per day throughout ninety days

### Grain Versus Screenings For Fattening Lambs.

MONTANA STATION BULLETIN No. 31.

Two lots of lambs of 53 each were fed for eighty-eight days

clover and marketable oats and barley, the other on clover and second mill screenings. The clover was valued at \$5.00 per ton, the mixture of oats and barley at 85 cents per cwt. and the screenings at 55 cents per cwt. The following results were secured:

Gain per head per month from feeding clover, barley and oats, 8.5 lbs  
 " " " " clover and screenings, 9.5 lbs

Food required per pound gain with clover and grain, clover, 5.5 lbs  
 grain, 1.07 lbs.

Food required per pound gain with clover and screenings,  
 clover, 5 lbs.  
 screenings, .94 lbs.

Cost per 100 pounds increase from feeding clover and grain, \$4.34  
 Cost per 100 pounds increase from feeding clover and screenings, \$3.34

The results from feeding clover and screenings indicate both greater gain in live weight and much greater economy in production than where grains were used. This is no doubt due to the variety afforded by the screenings which are relished by the fattening sheep.

### Clover Versus Grain Hay for Fattening Lambs.

MONTANA STATION BULLETIN No. 31.

Two lots of lambs of 53 each were fed for 60 days, one on clover hay, the other on grain hay. The grain hay was made from a mixed growing of spring wheat, oats, barley and peas in equal amounts, cut while in the dough stage. Both foods were valued at \$5.00 per ton.

The gain per head per month from the clover was 7 pounds.

The gain per head per month from the grain hay was 5.34 pounds.

The clover required to produce a pound of gain was 14 pounds.

The grain hay required to produce a pound of gain was 18 pounds.

Cost per 100 pounds increase from feeding clover, \$3.63.

Cost per 100 pounds increase for feeding grain hay, \$4.60.

---

There was a large waste from feeding grain hay consisting of coarse cereal stems. We concluded that it was better suited to cattle than sheep.

### Effect of Water Supply on Fattening Lambs.

MONTANA STATION BULLETIN No. 31.

Seventeen lambs were selected and fed clover and screened grain in the same manner as the pen of 53 heretofore described except that the former were turned to water but once a day while the latter had constant access to it.

The gain per head per month from the lambs with access to water was 9.5 pounds.

The gain per head per month from the lambs watered once a day was 7.15 pounds.

---

Cost of 100 pounds increase from lambs with access to water, \$4.51.

Cost of 100 pounds increase from lambs with restricted water supply, \$4.51.

---

While range stock may be able to subsist for long periods without water, these facts emphasize strongly the urgent necessity for a constant supply of good pure water for the fattening lamb.

### Comparative Results from Feeding Lambs, 1-year Wethers and Aged Ewes.

MONTANA STATION BULLETIN No. 15.

Four lots of typical range sheep were procured and fed 8 weeks. The foods, water, surroundings and methods of feeding were the same in all cases.

### Prices Paid and Weights when Test Began.

lambs, \$1.62 per head, average weight 62.9 pounds.

one-year wethers, \$2.50 per head, average weight 94.9 pounds.

two-year wethers, \$2.65 per head, average weight 115.7 pounds.

ewes, \$2.50 per head, average weight 91.6 pounds.

### Average Amount of Food Consumed per Head per Day.

lambs, clover 2.05 pounds, barley .68 pounds, total 2.73 pounds.

one-year wethers, clover 3.77 pounds, barley .68 pounds, total 4.45

two-year wethers, clover 4.05 pounds, barley .68 pounds, total 4.73

ed ewes, clover 2.33 pounds, barley .68 pounds, total 3.01

The total amount of food consumed by the lambs is rather small, their ration contained a greater percentage of grain than those of the sheep.

### Relation of Grain to Coarse Food.

The lamb ration consisted of 24 per cent grain.

The one-year wether ration consisted of 15 per cent grain.

The two-year wether ration consisted of 14 per cent grain.

The ewe ration consisted of 22 per cent grain.

These differences in the percentage of grain were necessary to give the various lots uniform finish when slaughtered. The heaviest ration was furnished the lambs to give their growthy increase. This was not considered so necessary in the case of the more mature wethers, whose increase in weight is largely fat.

### Increase in Live Weight during Eighty-Eight Days.

Lambs, 23.7 pounds, percentage increase 37.7 per cent.

One-year wethers, 23.5 pounds, percentage increase 24.7 per

Two-year wethers, 24.3 pounds, percentage increase 20.9 per

Aged ewes, 15.6 pounds, percentage increase 17.0 per cent.

The comparative gains are strikingly brought out in the percentage increase.

### Relative Cost of Production.

Lambs, cost per 100 pounds increase, \$4.18.

One-year wethers, cost per 100 pounds increase, \$5.83.

Two-year wethers, cost per 100 pounds increase, \$5.90.

Aged ewes, cost per 100 pounds increase, \$6.78.

While the lamb and ewe rations contained the same foods in the same proportions, the wether rations contained much less grain.

### Food Required for Maintenance and per Pound Increase.

Lambs, dry food consumed per pound increase, 10.16 pounds.

One-year wethers, dry food consumed per pound increase 10.16 pounds.

Two-year wethers, dry food consumed per pound increase 10.16 pounds.

Aged ewes, dry food consumed per pound increase, 17.5 pounds.

These amounts are larger than they would have been had no grain been used in the ration as heretofore indicated.

### Slaughter Test Report (By Swift & Co.).

55 lambs, average 79 pounds, price \$6.80, dress 54.2 per cent.

51 one-year wethers, average 108 pounds, price \$5.85, dress 54.2 per cent.

53 two-year wethers, average 123 pounds price \$5.40, dress 54.2 per cent.

3 ewes, average 95 pounds, price \$4.75, dress 50.6 per cent.

We consider all of these sheep a useful class of stock, not too  
d they are dressed about 2 per cent above the average, coming  
Chicago market at the present time."

he percentage of dressed weight is figured on a basis of actual  
t immediately after killing, shrunk 3 per cent. which is about  
utton will shrink after hanging over night.



BULLETIN No. 40,

**MONTANA AGRICULTURAL**

**xperiment Station,**

—OF THE—

**Agricultural College of Montana.**

**ROOT CROPS IN MONTANA.**

**Bozeman, Montana, November, 1902.**

**REPUBLICAN,  
Bozeman, Montana,  
1902.**



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J. W. BLANKINSHIP, PH. D.,.....	B
R. A. COOLEY, B. Sc.,.....	ENTOM
R. W. FISHER, B. S.,.....	Assistant Horti
EDMUND BURKE,.....	Assistant C

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All communications for the Experiment Station should be addressed to the  
Director.

## MONTANA EXPERIMENT STATION,

**Notice.**--The Bulletins of the Station will be mailed free to any c  
Montana who sends his name and address to the Station for that purpose.

# Montana Experiment Station.

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BULLETIN NO. 40.

NOVEMBER, 1902.

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## ROOT CROPS IN MONTANA

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By R. S. SHAW

While root crops have hitherto been grown in small quantities in Montana, there is nevertheless a useful place for them. The grazing system and the more recent work of production of grains rapidly giving way to a diversified farming as the cultivated areas being extended and tilled in a more progressive manner. Field crops will hereafter play an important part in the stock feeding operations of the farmer, for even though it has been clearly demonstrated that beets can be successfully produced for sugar making, there are no manufacturing plants in the state to use them for this purpose and they may not be made accessible to the majority of farmers in the state for some time to come. Our plan, therefore, is to discuss the question from the stock-growers' standpoint.

We take the ground that farmers that are so situated should have small areas of roots each season for winter feeding; for such work should be conducted on every farm in Montana where grain, legumes and roots can be grown. The growth of large areas of root crops is not present not recommended and in fact should be discouraged for several reasons, that in general we are not prepared to handle, house and store the large crops. It is a good plan to start with from one-half to one acre and this area can be enlarged to suit the demand. Although some objections have been raised against the growing of roots in Montana, such as, high price of labor and amount of work involved and lack of storage facilities. The cost of production and many difficulties pertaining thereto can be easily overcome by making use of the proper methods of culture and harvesting for our conditions; it is therefore proposed to discuss more fully.

### Value and Use of Root Crops.

Proof has already been secured which demonstrates clearly the usefulness of mangolds, carrots, sugar beets, turnips and rutabagas under our farm conditions. There is no class of stock kept on a ranch during the winter which can not be made to use some one or more of these to good advantage. In most cases it may not be possible to grow all five kinds, as some are better suited for certain purposes. The kind or kinds grown must be governed somewhat by the soil, climatic conditions and the class of live stock to which they are fed. For the horse, carrots are pre-eminently suitable; for the cow, mangolds, carrots and sugar beets; for the beef steer and sheep all are suitable; for the pig, mangolds, carrots and sugar beets; for the chicken, mangolds only. This classification of general use is based upon the use of roots in the raw condition.

The advantages derived from the use of field roots in feeding stock is due rather to a secondary action than to the actual amount of nutriment supplied by them. During the winter season when green foods only are available they furnish a succulent adjunct which acts as a tonic, stimulating digestion, increasing the flow of milk and thus saving a great saving in the more expensive grain foods. Station

as well as elsewhere have proved that roots and grain form a more economical ration for pigs than grain only; that the increase in live weight is relatively greater, the cost of production less and the quality of the meat of a higher grade. The comparative feeding values will be discussed in another publication.

### Conditions in Montana are Suited to Root Crops.

Though the soil and climatic conditions are extremely variable, there is scarcely a single cultivated portion of the state under irrigation where one or more varieties of field roots cannot be grown, from the lowest point up to an altitude of several thousand feet. Abundant proof of this assertion has been secured by the Experiment Station in regard to the sugar beet which has been almost universally produced in the state with satisfactory results from a sugar making standpoint; for several classes of roots it is probably the most difficult to produce. The mangold cannot be produced with best results at high altitudes where the growing season is short; the greater part of its weight being above ground with a sparse covering of leaves the flesh, which is covered with a thin skin, is easily damaged by early frosts. Frozen the roots do not keep well during the winter. The turnips of the four classes are not so readily injured by frost and all grow late in the season. In some sections particularly where the soil is clayey where the growth is retarded by lack of moisture, both turnips and mangolds are seriously damaged by the green aphid, the ravages of which are much worse some seasons than others. Of the whole number of carrots have been less liable to the ravages of insect pests, though turnips and sugar beets are seldom attacked. As yet plant diseases of a fungoid nature are entirely unknown among root crops in Mon-

### Soils Suitable for Root Crops.

While these differ slightly for the several classes and will be discussed more specifically later, in general, the heavier loams are best. Heavy clays are not suitable in any case and humus or muck are productive of quantity rather than quality. While the best

results will be secured from clay and sandy loams containing humus the yields will decrease as the soils become sandy or g both through lack of plant food and the inability of these s retain moisture. The land chosen should be so located that wa be applied just when needed; it should also be as nearly level a sible with just sufficient fall for irrigation. Where the fall is great with the system of furrow irrigation used, there is much w of the soil and resulting injury to the crop.

### Preparation of Soil.

In this there will be some slight differences according to t matic conditions, soil, and the crop to be grown. In all case plowing must precede the crop and in some cases this must be spring and in others in the fall. In those portions of the state the soil is somewhat heavy, where there is a large amount of s followed by copious spring rains and where as a result the gro impacted, then spring plowing will be necessary in certain seas under these conditions light porous soils should be fall plowed. dry, impenetrable soils produce prongy roots which are parti objectionable in the case of the sugar beet. Throughout the m sections with scant snowfall and spring rain the ground sho plowed deep in the fall and may also be cultivated some at tha In preparing the seed bed some form of cultivator should b which will cut deep and leave an even surface, this should be fo by a smoothing harrow to level the ground and bring the lumps surface. If the ground is too loose or lumpy it should be rolled seeding. After this the ground is ready for marking and s Where only a small area is sown it will be better to mark off the in order to have them straight and a uniform distance apart wh only adds to the appearance but renders cultivation and irri more easy and less liable to injure the crops. A marker may b constructed as follows: Cut several wooden runners about eighteen long out of one by eight-inch boards and round them off at one about the same shape as a sleigh runner; this rounded edge also be brought to a wedge shape. These runners are then fa together, side by side, the distance apart which the rows are re

nailing two 1x6 inch strips across the tops. A light strip is then attached to the centre of the marker by which it can be drawn. With a marker of this kind five or six feet in width an acre of ground can be marked off in an hour or two. The runners can be changed so as to suit the requirements as to distance in marking for any of the root crops or potatoes. This method is suggested for small areas only; larger areas should be marked and planted by a seeder for the purpose.

### Seeding.

Where large areas are to be grown year after year, a regular root drill should be secured. In the case of mangolds or sugar beets, the seeds of which are large, the sowing may be performed with an ordinary grain drill by stopping up some tubes to give the rows a proper distance apart. But where only small areas are planted the work can be well done with a good hand seeder of which the Planet Junior is a fair type. Using one of these a man can sow one acre of sugar beets, with rows two feet apart, in from three to four hours. These planters can be adjusted to sow all kinds of field roots and garden seeds as well. Every farmer who plants a garden should use one. The methods of cultivation and irrigation required by the various root crops will be left to be discussed individually.

### Harvesting.

The labor required and the cost of this operation are among the strongest arguments urged against the production of root crops. If the practice of hand pulling is followed much hard work and expenditure are required. The plan followed at the Experiment Station has been the following: The first operation in harvesting consists in removing the top. This can be rapidly and easily accomplished with a sharp hoe, the work being done nearly as fast as a man can walk. It is most easily accomplished in the case of the rutabaga, the top of which is supported on a neck. With practice and the exercise of proper care all classes of roots can be topped in this manner. Exception may be urged in the case of the mangold, as it has been considered necessary to twist the tops off in preference to cutting the root,

which renders them more liable to decompose. While this is true in humid climates, it does not hold good under our arid conditions. In the case of sugar beets to be used for manufacture it is desirable that a portion of the crown be removed with the top.

The next operation in harvesting consists in plowing the crop out. The deep rooted crops, such as mangolds, sugar beets and rutabagas, can not be overturned in many cases, owing to the depth to which the plow would need to go. In such cases our practice is to plow a deep furrow away from the roots and so close up to the row that the roots are left exposed. They can then be thrown into piles or gathered in a wagon. In doing this work only one row at a time can be moved, or two when working from both sides of the patch. If a number of rows were plowed before removing the outer ones these would be partially covered when the rows are close together. Both mangolds and rutabagas can be plowed out. The draught should be so arranged as to cause the plow to cut a V shaped furrow directly under the roots. As these two crops grow on the surface so little earth is moved by the plow that a whole field can be plowed out at once. If care is taken not to plow too deep the roots will be left exposed. In all cases a plow cutting not wider than ten inches will give the best results. The form of garden plow will answer well. For large crops a sugar beet harvester should be used.

### Storing

The most satisfactory and permanent results in storing are secured from a root cellar built in an excavation, the object being to get below ground for security against frost. Storage houses for mangolds and potatoes are not as satisfactory and are expensive. The best method of surrounding an excavated cellar, where there is little exposure to the atmosphere and its weathering influences, can be made of concrete, which is a cheap form of wall, as cobble stones for the structure can be found on nearly every farm and aside from the amount of lime and cement required there is little expense except for the labor, which in most cases can be performed by the farmer during seasons when his other work is least pressing. One of the main objects to be considered in a

of this kind is ventilation; the climatic conditions are such that the protective qualities of a root house are not put to the extreme test except during a few cold spells of short duration. Throughout the balance of the time the necessary ventilation should be available so that the temperature may be kept as near 32 degrees without freezing, which will give the best results. Owing to the dryness of the air it has been found that our root crops will keep much better in storage where some dirt is carried in along with them, such as may adhere in harvesting. This is particularly true of sugar beets. The earth should not, however, be allowed to become packed as might occur underneath a window or the drop where roots are shoveled in, for in this case they would heat and rot. In storing root crops high temperatures must be avoided.

Pitting may also be resorted to, but is not so satisfactory as a cellar. Under such conditions the continuous use of roots for feeding is interfered with during the extremely cold spells as some days the pit would have to remain closed to prevent the access of frost. In constructing a pit, a high, well drained piece of ground should be chosen. The roots should be piled in long piles, the bottom of the pile about four feet wide, with the sides sloping upward, to meet at a point  $3\frac{1}{2}$  feet above the center of the pile; the length of the pit can be governed by the conditions. As soon as roots are piled cover them with a layer of about three inches of straw, free from chaff; then cover the straw with earth taken up from near the edges of the pit in such a way as to form a ditch around the same for drainage. Early in the season not more than an inch or two of earth should be placed on the straw, but later, as cold weather approaches, double the amount of earth, and prevent freezing in future by coverings of manure, used in such quantity as the severity of the weather may require. Where the conditions are extreme, or for potatoes, a double covering may be used as follows: First cover with straw and then with a thin layer of earth, which is allowed to freeze, then follow with another layer of straw and more earth. In this method a dead air space is maintained and the roots or potatoes enclosed are not effected by fluctuations in temperature from without. In extreme weather a manure covering would be needed as in the first case.

## Sugar Beets.

Practical demonstrations prove that beets can be produced in Montana for sugar production quite as successfully as anywhere in the world; this is true both as regards quality and yield. As there are no factories for the production of beet sugar in the state at present, as this publication is being prepared more especially for the stock raiser and farmer who may be interested in feeding problems, the following data relating to culture will apply more specifically to the production of these roots for feeding purposes.

### (1) NATURE OF GROWTH.

The sugar beet is particularly characterized as a deep grower, producing a long conical tap root extending on the average from twelve to fifteen inches deep. When properly planted and cultivated, the growth should be almost entirely beneath the surface of the ground because of this and the additional fact that the top consists of springing short stemmed leaves, these plants are not injured by the early frosts.

### (2) SOILS BEST SUITED.

On suitable soils with proper conditions sugar beets can be grown from sea level up to an altitude of 5,000 feet, but a short season may be a disadvantage. Stiff clay soils should be avoided, and humus and muck soils, while not suited to the growth of the best quality of beets for sugar making, can be used where stock food is being produced. Sandy loams are preferable, but any rich loam will answer. The soil should be deep, as the presence of hardpan too near the surface causes poor roots. Under semi-arid conditions, when poor soils are used, require farmyard manure, this should always be applied with the preceding crop.

### (3) PREPARATION OF SEED BED.

In general, the plowing should be deep and done in the fall except under those local conditions where heavy snows or spring rains soften the ground, then it should be replowed in the spring and thoroughly cultivated to reduce it to fineness and render it retentive of moisture.

Spring plowing should be done early and followed by cultivation at intervals till sowing time and preparation completed as heretofore described.

#### (4) PLANTING.

In this the time will depend on local conditions, of which we have an endless variety; but in general the planting should be done as early as the working of the soil and the climatic conditions will permit. The rows should not be more than two feet apart; a less distance is recommended in growing beets for sugar making but for the purpose given two feet will answer well, providing more room for cultivation. The rows should be laid out in such a manner that a fall of not more than three-fourths of an inch to the rod will be given; if the fall is greater the tendency will be to wash the soil from between the rows, leaving the minute roots exposed and injuring the plants. Large areas should be sown with a regular drill but smaller ones with a garden seeder. Not less than twelve pounds of seed should be used per acre, in order to insure a perfect stand. If the soil is moist plant the seed three-quarters of an inch deep; if dry, one and one-quarter inches or even a little more.

#### (5) CULTIVATION.

If a heavy loam should bake as the result of a dashing rain, the plants may be prevented from coming through. In extreme cases only, where the crop is thus endangered, a very light harrowing may save it, if done as soon as the ground is dry and before the plants reach the surface; this should only be attempted in extreme cases. For small areas of an acre or so, cultivation by means of a hand wheel hoe should be given as soon as the plants are all nicely through the ground; adjust the wheel hoe with the two-knife attachment made to run one on each side and close up against the row. This prompt cultivation will prevent evaporation and save much future labor by destroying the young weeds. The remaining portions of the spaces between the rows may be left for horse cultivation later. The wheel hoe can be used before such time as a horse could follow the row and also avoids the danger of covering the small plants with a horse cultivator. Subsequent cultivation should be fre-

quent, deep at first and shallower as the season advances. Thin the plants to eight inches apart in the row when the second pair of leaves appear and when about two inches high, without drawing the plants away from the plant; later thinning is both more injurious and more difficult. In the thinning the interspaces can be cleared by means of a hoe and the remaining bunches thinned by hand. Where the plants are not too thick the work can all be done by a hoe in the hands of an expert. The more the hands are used in thinning the more it becomes a necessity. If the beets are properly thinned and the weeds all removed from the row at the same time subsequent use of the hoe will be very little required. Do the work well the first time.

#### IRRIGATION.

Preparations for this are made at the same time cultivation is given. By attaching a v-shaped point to the centre of the shank of the cultivator a small scratch or furrow is left to lead the water, and the smaller this is the better providing it answers the purpose without overflowing. Flooding should always be avoided in the care. The amount of irrigation will depend on the local precipitation, some localities requiring one, others two and still others three applications. The indications of need of water are the turning dark of the top leaves and the wilting of the lower ones. The water should be allowed to run till the earth between the furrows all turns from saturation when it should be promptly turned off. Cultivate lightly as soon as ground is dry enough after irrigation to prevent evaporation.

Sugar beets may be irrigated up to within six weeks of harvesting. They should not be harvested while frozen. Though hummocky soils and those containing some alkali produce beets of a poor quality for sugar making, this need not deter the farmer producing them for stock food.

#### Mangolds.

These are admirably adapted to all classes of live stock but are especially valued for milch cows as they can be freely used without danger of tainting the milk. As a winter food for fowls none

replace them when fed raw. Mangolds are of several varieties differing in color as red, orange and yellow: and also in shape, as oblong or globular. The long varieties usually give much larger yields.

#### NATURE OF GROWTH.

The mangold is particularly characterized by an upward tendency of growth so that when mature a large portion of the root is exposed. The leaves are more sensitive to frost than the sugar beet and the same is so true of the root which is covered by a very thin skin.

#### SOILS BEST SUITED.

These are all deep soils rich in organic matter. Clay loams, strong loams, and dark prairie soils are especially adapted, while stiff soils and light sands are less suitable.

#### PREPARATION OF SEED BED.

In general the same as for sugar beets.

#### PLANTING.

Those methods described for the sugar beet will apply in general to the mangold also. From six to eight pounds of seed is required per acre but the amount should be governed by suitability of the soil and conditions. The distance between the rows and also the plants in the row will vary with the variety chosen, the conditions of the soil, the season or lateness of sowing and the length of the growing season. The larger the variety, the richer the land, the earlier the date of seeding and the longer the season, the wider apart should be both rows and plants in the row and vice versa. Twenty-seven inches is an average distance for the rows and twelve inches for the plants in the row.

#### CULTIVATION AND IRRIGATION.

In general the same as for sugar beets.

### Carrots.

This crop can be grown with more certainty throughout the state than any other and is less liable to attacks of disease and insect pests than any other. They are equally useful for all classes of live stock.

and especially for horses at that season of the year when they are deprived of succulent food, as they are greatly relished by them in raw state.

(1) NATURE OF GROWTH.

It is such that the carrot crop is not injured by the early frost of spring or autumn and has great power to resist drouth so when started in the early spring a crop can be looked for with most unfailing certainty. Crops can be produced without irrigation in those sections where there is some sub-irrigation or a fair amount of rainfall. The carrot is a deep grower, developing entirely within the ground. The varieties are classified as long, medium and short and also by their color, as red, orange and white. The varieties are losing favor owing to the difficulty in harvesting them.

(2) SOILS BEST SUITED

Almost any soil with a fair amount of plant food will grow a good crop of carrots. The favorite soils are those of a deep loamy character, capable of retaining moisture. Some varieties are better adapted than others to shallower or heavier soils.

(3) PREPARATION OF SEED BED.

In this the work should be much the same as for sugar beets and mangolds but most of the work should be done in the autumn. The preparatory cultivation should be performed with a view to cleaning the ground from weeds. The spring cultivation should consist in preparing a fine mellow seed bed.

(4) PLANTING.

As there is little danger of injury from frost, plant as early as possible. Small areas will produce enormous yields if properly handled and these are most satisfactorily sown with a hand seed drill. Eighteen inches between the rows will suffice for the crop, but twenty-four is more frequently given to facilitate the ease of cultivation. From two to four pounds of seed are required per acre according to the suitability of the conditions.

## 5) CULTIVATION.

This should begin as soon as the young plants mark the line of the row, using the method heretofore described for mangolds and sugar beets. Prompt cultivation is more necessary in the case of the carrots as it is slow to germinate and come up, thus giving all weeds a good start. From a consideration of both quantity and quality the best results will be secured from thinning the plants to four inches apart in the row. This is the tedious and expensive operation of carrot culture as the thinning must be done entirely by hand. Where, owing to adverse conditions or poor seed the stand may be somewhat thin and irregular, a good crop may result without any thinning.

## 6) IRRIGATION.

This should be performed by the method described and less water will suffice than for most other root crops.

The harvesting which has been generally regarded as a laborious and expensive operation can be quickly and easily performed by the method heretofore described and need not be done before the approach of winter.

## Turnips.

These are of two varieties, viz., those of Swedish origin commonly called Swedes or rutabagas; the other class being known as Fall Turnips. The Swede turnips have the firmer flesh and are the better keepers; they are known by the purple, green or purplish green color of the top of the bulb and by the leaves which are a darker color than the fall varieties. Fall turnips vary greatly in the comparative strength of the tops and in the size, color, shape and texture of the bulbs. Turnips form an excellent food for many classes of live stock, but can not be satisfactorily fed to swine if raw, or to milch cows without danger of tainting the milk.

## 1) NATURE OF GROWTH.

This is such as to especially adapt them to moist, cool climates, but they give remarkable results in Montana wherever grown under

irrigation. The greater portion of their growth is made with rapidity in the autumn months.

(2) SOILS BEST SUITED.

Those of a free working, loamy nature are best for turnip especially where containing some sand but not sufficient to render them poor. Rich muck soils tend to stimulate too great a growth of tops with a corresponding deficiency in root. Our valley soils, however, are well suited to the growth of the turnip.

(3) The preparation of the land should be somewhat similar to that heretofore described as being deep and thorough.

(4) PLANTING.

This may be delayed to as late as June 10th in those localities where there are late spring rains to germinate the seeds; in other sections sowing should take place earlier. Twenty-seven inches suitable distance between rows and from two to four pounds of seed are required per acre. The seed may be sown with hand seeder or by means of a field drill providing the turnip seed is mixed with some kind of meal or sawdust or dry earth to give it bulk.

(5.) CULTIVATION.

Should begin early and be frequently repeated. The plants should be thinned to twelve inches apart as soon as two or three inches high. The work can all be preformed by means of a hoe, as the plants are not so liable to injury as sugar beets or mangolds.

(6). Irrigation should be practiced sufficiently often to keep the turnip plants growing vigorously. This is the most successful means of counteracting the attack of plant lice. The slow growing plants are the first to be attacked and the first to succumb.

Harvesting need not take place till late in autumn owing to the late continued growth and ability of the turnip to withstand frost. The crop can be topped by means of a hoe and plow as described.

## Potatoes.

The culture of potatoes must necessarily be greatly different because of the almost unlimited variety of conditions under which they are grown throughout the state. The methods considered must therefore be general rather than specific. Potatoes can be successfully grown in Montana, both with and without irrigation; in the latter case, however, only in such sections where the ground is moist from sub-irrigation or where there is more than the average precipitation.

### SELECTION OF VARIETIES.

These may be classed as early, medium and late, and such a schedule may be obtained from the Experiment Station at any time as new varieties are collected for testing. In most sections above an altitude of 6000 feet, early varieties only should be grown; medium sorts between 4000 and 6000 feet; and the later kinds below 4000 feet. The yields per acre are least from the early varieties, increasing as the time for maturity extends.

### SUITABLE SOIL.

The best results, considering both quality and quantity, are to be secured from rich loams containing some sand and much humus; stiff clays, mucks and light sands are undesirable.

### SELECTING SEED.

Too often the variety chosen is selected because of a large total yield with too little regard for quality. The value of a variety depends upon the percentage of marketable potatoes produced rather than upon the total yield. This is ascertained by deducting the small and rough potatoes from the product of a given area. Then in addition to this the potatoes should possess good shape, viz.: an oval neither tending to flatness nor long points at either end, with the eyes set well in on the surface. From a potato possessing this shape there is less loss in preparing for cooking. Much difference of opinion exists regarding the selection of tubers for seed. The best practice, however, is to select medium sized, smooth and uniform potatoes, notwithstand-

ing the evidence which may be produced to show that equal results in some cases, have been secured from small sets.

### Treatment for Scab and Preparation for Seed.

Potatoes selected for seed should always be treated for scab whether apparently affected or not, as the parasitic spores may be present even though not visible. The preventative measures are neither laborious or expensive, and a badly infected crop is practically unmarketable. Either of the two following methods may be used:

(1) Soak the uncut seed from one and a half to two hours in a solution consisting of one pound or pint of formalin to thirty gallons of water; or (2) Immerse the tubers for the same length of time in a solution consisting of corrosive sublimate in the proportion of one ounce to seven and one-half gallons of water. The former treatment is preferred as it does not present the deadly poison properties of the latter, nor corrode metallic vessels. These methods of treatment may not be effective in replanting badly infected ground; in such case the place of planting should be changed. The conditions seemingly favorable to the development of scab are soils possessing an abundance of decaying organic matter with an excess of moisture accompanying proper temperature. Past experience seems to indicate that heavy manuring or plowing in green crops accompanied by excess of moisture or copious irrigation, tends to increase scabbing.

The cutting process should always follow treatment. Though a number of devices have been invented for this work, none answer as well as a knife in the hands of a skilful operator. When the tubers are large with a moderate number of eyes, cut one eye to a piece of seed, leaving the seed end. With a variety having many eyes it may be necessary to cut two to each piece. After cutting, if storm prevents planting for a number of days, spread the sets out thin on a board floor and sprinkle with dry earth or ashes to hasten the callousing of the sets and prevent decomposition, which will, soon follow if the sets are piled or sacked. Under local conditions where spells of cold, dry weather are likely to follow early planting, uncut seed about the size of a hen's egg is safer to plant, being much more resistant to decay.

attention should also be given to the selection of perfectly matured seed. In some localities early frosts may destroy the vines before maturity. While the immature tubers will grow quite well they are much longer in starting and making an appearance above ground. Potatoes also which have been exposed to any possibility of even slight freezing should not be used for seed.

#### PREPARATION OF THE SOIL

Deep plowing and thorough cultivation are essential to render the soil loose and mellow. Fall plowed land, which has settled and become hard, should always be replowed shortly before planting time.

#### PLANTING.

The labor involved in planting large areas will justify the purchase and use of a potato planter; any one of the several kinds on the market will do excellent work. In general the drills should be from thirty-six to forty-two inches apart with the sets twelve inches apart in the row. For small areas drill rows may be opened with a small plow and refilled with the same implement after planting. The drills should not remain open long to allow them to dry out. After covering with the plow cross harrow to level the ground; this is particularly necessary where the crop is to be irrigated. A covering of four inches with the heavier and more retentive soils is sufficient, but six inches may be needed in the lighter and drier ones.

#### CULTIVATION.

Harrow lightly at once as soon as the young plants begin to appear above ground to destroy weeds and retain moisture. Frequent cultivation should follow according to the conditions; the drier the season the more frequent the cultivation. More cultivation and less irrigation will produce crops of better quality.

#### IRRIGATION.

In this the time and amount is greatly varied by the local climatic and soil conditions. In general one irrigation can be made to suffice if proper cultivation is given and the water applied about the time the

ants come into bloom. Earlier irrigation is liable to start too sets; delayed too long a second growth producing rough potatoes likely to occur. Under the most extreme conditions two irrigations may be necessary. After irrigating, the ground should be cultivated lightly to prevent evaporation. The same method of irrigation as described for sugar beets will also apply to potatoes.

#### HARVESTING AND STORING.

Large areas are readily harvested with a potato digger such as the Hoover. In storing, the secret of success lies in keeping the potatoes in a dark storeroom or cellar with the temperature as low as possible without permitting freezing.

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LLETIN NO. 41.

**MONTANA AGRICULTURAL**

# **Experiment Station**

**OF THE**

**AGRICULTURAL COLLEGE OF MONTANA.**

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## **SUGAR BEETS.**

**THE CROP OF 1902.**

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**BOZEMAN, MONTANA, DECEMBER, 1902.**

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**1902.**

**The Avant Courier Publishing Co.  
Bozeman, Montana.**



# Montana Agricultural Experiment Sta

Bozeman, Montana.

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**Notice.**—The Bulletins of the Station will be mailed free to any citizen of Montana who sends his name and address to the Station for that purpose.

# Montana Experiment Station.

Bulletin No. 41

December, 1902

## SUGAR BEETS.

The Crop of 1902.

F. W. TRAPHAGEN.

Except for the fact that very few of the cooperating farmers responded to the request to send to the Station samples of sugar beets for analysis, the results of the year's work are very satisfactory.

No general conclusions can be drawn from the analysis of such a small number of samples for the various localities, though these results, so far as they go, support the conclusions of former years.

The season has been very generally reported as having been very unfavorable to the growth of beets, yet the yields, both in quantity and quality, have been very good.

The richest lot of beets that has yet come into the laboratory was grown by W. M. Wooldridge, Valley county. Six beets raised by Mr. Wooldridge averaged 22.8 per cent sugar in the beets, equivalent to 24 per cent sugar in the juice.

Results, this year and in past years, show that the manufacturing campaign might begin as early as the middle of September, thus making a campaign of great length possible.

Excellent yields of fine beets have been obtained this year with very little water, in some cases none in fact, reaching the crop from planting until harvesting. This would indicate the possibility of its use as a dry land crop, in places where water is not available.

TABLES OF COMPOSITION, YIELD AND VALUE

Laboratory No....	Co-operating Farmer.	Locality.	Date Analyzed	
2250	J. R. Stevens	Bridger, Carbon County	September 26	Dip
2251	F. E. Wedge	Columbia Falls, Flathead County	September 26	Hoa
2252	Ebenezer Johnson	Fulton, Lewis & Clarke County	September 26	Vib
2255	Theo. Koenig	Kalispell, Flathead County	October 17	Hoa
2256	J. H. Green	Manhattan, Gallatin County	October 17	Str
2257	H. O. C. Andrews	McLeod, Sweet Grass County	October 17	Str
2258	J. J. Quinlan	Forsyth, Rosebud County	October 17	
2259	Fred Edelman	Sheridan, Madison County	October 26	Hoa
2260	A. B. Leckenby	Union, Union County, Oregon	October 26	Dip
2261	J. P. Jones	Whitehall, Jefferson County	October 26	Str
2262	G. Hollenbeck	Pioneer, Powell County	October 26	Vib
2263	J. J. Quinlan	Forsyth, Rosebud County	October 26	Vib
2264	J. R. Stevens	Bridger, Carbon County	October 26	Dip
2265	W. M. Wooldridge	Hinsdale, Valley County	October 27	Str
2266	Isaac Eddy	Lothrop, Missoula County	October 27	Vib
2267	H. R. Ballinger	Red Lodge, Carbon County	October 27	Dip
2268	Mrs. B. Hauck	Garrison, Powell County	October 29	Vib
2269	A. L. Halliday	Choteau, Teton County	October 29	Vib
2270	A. C. Gifford	Fallon, Custer County	October 29	Str
2274	C. M. Larkin	Bridger, Carbon County	November 5	Dip
2275	W. E. Milnor	Troy, Flathead County	November 5	Vib
2276	M. M. Ferguson	Bozeman, Gallatin County	November 5	Hoa
2277	Lewis Krueger	Bozeman, Gallatin County	November 7	
2282	Experiment Farm	Bozeman, Gallatin County	November 7	
2283	J. B. Dugans	Ekalaka, Custer County	November 7	Dip
2284	T. S. Proud	Kalispell, Flathead County	November 29	Str
2285	T. S. Proud	Kalispell, " "	November 29	Dip
2286	T. S. Proud	Kalispell, " "	November 29	Vib
2287	F. E. Wedge	Columbia Falls, Flathead County	November 29	Hoa
2288	E. H. Ellinger	Melville, Sweet Grass County	November 29	Vib

## TABLES OF COMPOSITION, YIELD AND VALUE—CONTINUED.

Average Weight	Per cent sugar in juice.....	Per cent sugar in Beets.....	Per cent purity.....	Yield tons per acre	Pounds sugar per acre.....	Return to Farmer per acre Ohio Standard.....
nds 1 ounce	18.9	17.95	81.4	14	5026	\$ 90.72
nds 3 ounces	16.4	15.6	81.5	14	4468	79.80
nd 9.5 ounces	13.9	13.2	78.1			
nds 11.5 ounces	16.7	15.9	80	19.5	6201	113.10
nces	15.9	15.1	82.8	20	6040	110.60
nd 10 ounces	16	15.2	83.3	27	8208	150.12
nd 10 ounces	20.4	19.4	81.2	17.5	6790	121.80
nd 3 ounces	17	16.2	82.9	21	6802	123.90
nd 7 ounces	14.2	13.5	86.6	18.3	4954	91.75
nces	13.5	12.8	75.4	10	2560	47.60
nces	13.8	13.1	80.2	11	2882	53.46
nd 7 ounces	14.4	13.7	57.6	17.5	4796	88.55
nd 4 ounces	18	17.1	78.6	14	4788	86.80
ounces	24	22.8	77.4	20	9120	161.80
nd	16.3	15.5	87.2	17.5	5125	90.05
nd 9 ounces	15.7	14.9	85.3			
nd 15 ounces	14.6	13.9	81.6			
nd	15	14.25	86.2			
nd 4 ounces	17	16.15	87	31.75	10255	186.69
nces	18.8	17.86	89.1	12	4286	77.40
nces	16.9	16	83.6			
nd 1 ounce	16	15.2	84.2	22	6688	122.32
nces	18	17.1	80			
nd	17.9	17	91.3			
nd 7 ounces	18.6	17.7	80.1			
nd 7 ounces	17.7	16.8	81.2	14	4704	85.40
nd 1 ounce	19.6	18.6	83	11	4092	73.70
nd 5 ounces	17.6	16.7	82.2	16	5344	96.96
nd	19	18	81.2	14	5010	91.00
nds 8 ounces	15.5	14.7	72.4	24.6	7232	132.84

## TABLES OF CULTURE NOTES.

Laboratory No....	Co-operating Farmer.	Soil	Date planted	Date Harvested	b
2250	J. R. Stevens	Clay, gumbo	April 14	September 15	16
2251	F. E. Wedge	Sandy loam	May 24	September 22	18
2252	Ebenezer Johnson	Black loam	May 18	September 23	22
2255	Theo. Koenig	Black sandy loam	May 21	October 8	18
2256	J. H. Green	Black garden loam	May 6	October 9	16
2257	H. O. C. Andrews	Black soil	May 5	September 26	20
2258	J. J. Quinlan	Sandy loam	May 10	September 29	21
2259	Fred Edelman	Sandy loam	May 12	October 14	12
2260	A. B. Leckenby	Clay loam	April 28	October 15	20
2261	J. P. Jones	Sandy loam	May 20	October 16	20
2262	G. Hollenbeck	Black loam	May 20	October 12	18
2263	J. J. Quinlan	Black soil	May 5		
2264	J. R. Stevens	Clay, gumbo	April 15	October 15	16
2265	W. M. Wooldridge	Sandy loam	May 1	September 20	18
2266	Isaac Eddy	Black loam	May 6	October 21	18
2267	H. R. Ballinger	Sandy	June 20	October 24	28
2268	Mrs. B. Hauck	Sandy loam	June 29	October 22	24
2269	A. L. Halladay	Sandy loam	May 16	October 25	24
2270	A. C. Gifford	Sandy loam	May 18	October 25	20
2274	C. M. Larkin	Sandy loam	May 12	November 2	16
2275	W. E. Milnor	Sandy loam	May 20	October 31	24
2276	M. M. Ferguson	Black loam	June 2	October 28	36
2277	Lewis Kruger				
2282	Experiment Farm	Sandy loam			
2283	J. B. Duggins	Sandy loam	May 20	November 3	18
2284	T. S. Proud	Sandy loam, very deep	May 18	November 16	18
2285	T. S. Proud	Sandy loam, very deep	May 18	November 15	18
2286	T. S. Proud	Sandy loam, very deep	May 18	November 16	18
2287	F. E. Wedge	Sandy loam	May 24	November 17	18
2288	E. H. Ellinger	Sandy loam	May 5	November 19	20

## TABLES OF CULTURE NOTES—CONTINUED.

Irrigation.	Cultivation.	Remarks.
<p>ent and plentiful. no water from June 23, y dry very little rain. times, June 15, July 20, ust 12. June 10 and July 15. ation and no rain. n June and in July</p>	<p>Plowed 10 inches deep, no subsoiling. Thinned June 28. Thinned June 11.</p>	<p>Season unfavorable. Season unfavorable. Season unfavorable.</p>
<p>Plowed 7 inches deep. Plowed 7 &amp; 8 in. deep, cultivated with garden plow; thinned June 20. Thinned June 16. Thinned June 15. Plowed 8 inches deep, not subsoiled; thinned June 15. Plowed 9 inches, subsoiled 4 inches, stand excellent, thinned June 2. Thinned July 10. Thinned June 30, hoed twice 4 inches deep; stand excellent.</p>	<p>Thinned June 20. Thinned June 20, plowed 7 inches, subsoiled 7 in.; frequent cultivation. Thinned July 6 to 15. Thinned June 20. Early in July; plowed about 6 inches; good stand. Thinned July 1. Plowed 8 inches deep; thinned July 1; stand medium. Thinned July 7, July 28 and Aug. 11.</p>	<p>Season favorable. Season unfavorable. Season unfavorable. Season very unfavorable. Season favorable. Season favorable. Season very unfavorable. Season very unfavorable.</p>
<p>10 days after July 10. ring July. f in. water to row every ays fr'm Jul. 5 to Aug. 25. une 20. rigations and several rain bail storms d twice. mes. rom well when watering en. n July and in August. oring wet. ugust 6.</p>	<p>Thinned July 11. Thinned June 20. Thinned June 20, plowed 7 inches, subsoiled 7 in.; frequent cultivation. Thinned July 6 to 15. Thinned June 20. Early in July; plowed about 6 inches; good stand. Thinned July 1. Plowed 8 inches deep; thinned July 1; stand medium. Thinned July 7, July 28 and Aug. 11. Thinned in June. Thinned July 12, plowed 8 inches; stand excellent. Thinned July 10. Thinned July 11. Thinned June 28. Thinned June 20, plowed in May 10 inches deep.</p>	<p>Season favorable. Season unfavorable. Season cold, v'ry unf'v'ble Season unfavorable. Season unfavorable. Fair season. Frost in June. Season very unfavorable. Season very unfavorable. Season favorable. Season unfavorable. Season unfavorable. Very cold and backward. Cold and backward. Season unfavorable. Season very unfavorable.</p>

1 did not come up till July 1, then not more than one-quarter of a stand.

Where beets have been allowed to remain in the ground they have ripened they have shown a marked deterioration. is shown in the case of samples 2250 and 2264, grown by Stevens, of Bridger, and in 2258 and 2273, grown by Quinlan, while on the other hand samples 2251 and 2287 show the opposite results, but in the latter case the ground was dry towards the end of the season, and soon after became covered with snow.

While occasional frosts are experienced after the crop is harvested, the sugar beet seems to be well adapted to withstand the severest such frosts as occur during the growing season in Montana.

The Continental Sugar Company, at Fremont, Ohio, pays \$4.50 a ton for beets testing 12 per cent sugar and of a purity of 80 degrees. For each per cent of sugar above 12 in the beet an additional  $33\frac{1}{3}$  cents is paid. I have calculated, on this basis, the return our Montana farmers would receive from each acre of beets planted, provided that the results obtained experimentally were also obtained on a larger scale. These figures are given in the tables.

Some of the beets have a purity of less than 80 per cent, and the farmer would not receive for these as much as the table shows. I do not know just how much is deducted for low purity, so I have been unable to subtract in the cases mentioned.

No averages are attempted this year because of the small number of samples analyzed.

APR 1922  
*Nathaniel Banks with the  
Camp of R. H. Cooley*

58,990

**BULLETIN NO. 42.**

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# AGRICULTURAL EXPERIMENT STATION

-- OF --

THE AGRICULTURAL COLLEGE

-- OF --

MONTANA.

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## THE CODLING MOTH.

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BOZEMAN, MONTANA, DECEMBER, 1902.

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BOZEMAN CHRONICLE--1903



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# Montana Experiment Station.

Bulletin No. 42. - - - - December, 1902.

## THE CODLING MOTH.

*Carpocapsa pomonella* Linn.

R. A. COOLEY.

Montana now has not far from 900,000 apple trees growing within her borders. Only about one-third of these have yet come into bearing and few, if any, have produced a maximum crop of fruit. Notwithstanding the newness of the industry, the production of fruit is already looked upon as one of our main branches of agriculture. There exists complete confidence in its future, and its development is being pushed forward with enthusiasm.

The fruit growers have wisely been looking into the future, and have recognized in the codling moth a serious menace to their orchards. Other insects also have been recognized as dangerous, and as a means of protection against all, a State Board of Horticulture has been created, the duty of the members of which is to prescribe regulations for inspection and disinfection of fruits and nursery stock, and otherwise afford protection.

Montana's problem with this insect is, in some particulars, a peculiar one. It has not yet gained a footing in our commercial orchards, and is present in destructive numbers in only a very few places, the most important of which is Missoula which lies at the lower end of the Bitter Root valley.

So far as the commercial orchards are concerned, the codling moth is not in Montana. The problem, then, is the one of taking the greatest possible advantage of the fortunate conditions. We

believe that by vigilance we can prevent the insect from getting to full possession of the orchards, as it has done in many parts of the country where it is necessary to use every means possible in order to get a remunerative crop of fruit. It is hoped that instead of allowing the moth to firmly establish itself and then trying to repress it, we may be able to prevent it from gaining a foothold.

The present paper aims only to discuss the moth from Montana's standpoint. We believe that every person interested in the production of Montana's principal fruit, the apple, should have an intimate knowledge of this insect which is the worst pest of the apple. Many are not familiar enough with the insect to know how serious a pest it is, and what it means to allow it to get into an orchard.

It is hoped in a future publication to give a more elaborate account of this important pest.

### THE STATUS IN MONTANA.

The only cases of infestation by the codling moth in Montana known to the writer, are here discussed.

As is now well known in the state, the moth was found to be doing considerable damage at Missoula in the summer of 1901. The situation was indeed quite serious, but since this season's work of the Experiment Station and Board of Horticulture, in cooperation, the cause for alarm has been very largely removed. Brandegee and the writer took a buggy drive up the Bitter Root valley from Missoula to Hamilton and return, for the express purpose of satisfying ourselves as to whether or not the moth is in the valley. It is very gratifying to report that we were unable to find a single example of the moth outside of Missoula.

Mr. H. C. B. Colville, while acting as inspector in the summer of 1899, located the insect at Thompson Falls. The writer is informed as to the condition of this colony at the present time.

Mr. Brandegee reports that the pest is well established in home yards in some parts of the city of Helena. It has been there a number of years to his knowledge, and is very destructive. He states that fully 95 per cent of the fruit in entire orchards in the residential districts was taken in 1902, but that there was only about one-half a full crop.

In August, 1900, Mr. Fred Whiteside of Kalispell sent wormy apples to the Station asking to be informed whether or not they were affected by this insect. Upon being informed that he actually had the moth in his orchard, he at once picked and destroyed all the fruit from the single tree known to be infected, and all those near by. Since that time no more moths have been seen in his orchard.

During the summer of 1902, Mr. O. C. Estey, of Bigfork, inspector for the district, found it in several localities in and near Kalispell. On August 26th he found about one-hundred wormy apples in one orchard. In two other orchards he found one and three trees respectively that were affected. We are inclined to believe the situation at Kalispell to be serious. Left to itself, the moth would sooner or later spread to the surrounding country.

#### ARE ANY PARTS OF MONTANA IMMUNE?

Many individuals have believed that the climatic conditions of Montana would prevent this insect from ever becoming a serious pest. Others have felt that the isolation of their orchards would make them immune. We believe that the moth is capable of becoming more or less destructive in any climate that will permit the profitable production of apples. This opinion is amply borne out by the experience of other states. Moreover, the fact that the moth has maintained itself so well in Missoula and Helena confutes any theory of immunity for places of similar climate.

It is true that widely isolated orchards may be kept free for a considerable time, perhaps indefinitely, if precautions are taken against bringing fruit boxes or other suspected material to the orchard.

#### THE POSSIBLE DESTRUCTIVENESS OF THE MOTH.

It is a well established fact that an insect pest is more abundant and destructive under climatic conditions favorable to its life and development, than outside of the climatic conditions to which it is adapted. The codling moth is no exception.

The United States has commonly been divided into five life zones as follows: boreal, transitional, upper sonoran, lower sonoran, and tropical. These zones are of irregular and broken outline, and extend across the continent from ocean to ocean. Three

of them cross Montana; the boreal, which includes the mountain tops; the transitional, which roughly speaking includes the agricultural valleys of the state, except those in the southeast corner, the latter being included in the upper sonoran; and the upper sonoran, which embraces the southeast corner as far north as the valley of the Yellowstone river, and west to an indefinite line in the vicinity of Big Timber.

No apples are grown in the boreal zone in Montana, and the moth is not found there. It follows, then, that all the apples grown in the state, except in the southern part, which at present are few, are in the transitional zone.

Without going into the details we may sum up the results obtained by various investigators in other states as follows: Where the insect is able to maintain itself, its injuries vary in different years, and it is always less destructive than in the next warm zone, the upper austral.

Professor Aldrich in Idaho and Professor Piper in Washington, after careful and comprehensive investigations, report that the amount of destruction varies from about 5 per cent. up to about 25 per cent.; on the other hand Professor Gillette of Colorado reports that at Fort Collins, which is in the same zone, from 10 per cent. to 70 per cent. is taken, and Professor Cordley has found that in a narrow strip of the transitional zone, near the coast of Oregon, the moth is also more injurious.

Under conditions existing in Montana it has been impossible to gather data of much value as bearing on the percentage of destruction by the moth. In the first place we were unable to go into large orchards and count the affected and clean apples as they were picked from the trees, since the only infested trees were in the home orchards of Missoula and vicinity. In the second place, such records, even if carefully kept, do not tell the whole story, since the effect of the first brood of larvae on some winter varieties, and of course on summer varieties, is to cause the apple to drop. These drop and wither and disappear before the harvest and are therefore not taken into reckoning if the comparison be made alone on the wormy and clean fruit at the time of harvesting.

We undertook to keep an accurate record of the wormy and clean fruit in the cage at Missoula, (described later in this paper) and reached the following results:

When the first brood of larvae was coming out of the fruit we counted 323 apples on the tree and on the ground, and of these 50 were wormy. It is very probable that a few more were wormy that did not appear so at that time.

On October 5th, we again counted the fruit on the tree and on the ground, and found 144 clean and 115 wormy. All the fruit affected by the first brood of larvae dropped to the ground and disappeared. If only 50 were taken by the first brood, 273 were left. There were 259 sound and wormy apples on and under the tree on October 5th. This number subtracted from 273 leaves 14 apples which were either taken by the first brood or dropped on account of failure to mature. Because of the failure to know what became of the 14, we are defeated in our attempt to get an accurate record of the percentage of destruction. It would perhaps have been possible if we could have put in an immense amount of time and been in the cage every day. It is obvious that no one could have prepared an accurate statement of the percentage of loss by a count at the time of harvest alone, as the apples destroyed by the first brood had disappeared and only 259 apples were to be found as against 323. If we premise that the 14 apples were sound we can figure that 51 per cent. was taken by the moth. The least percentage of destruction that we can calculate therefore is 51.

There are other facts that tend to lessen the value of estimates of loss. Unless the best of judgment is used in selecting from an orchard, representative trees from which to count the fruit, the deductions made from the counts of a few trees are misleading. The actual number of apples taken by the insects in years of full crop and in years of short crop, probably does not vary much, yet in years of scarcity the loss is felt much more keenly.

The crop in Missoula this season was probably a full one.

With some misgivings we venture to state that the loss to whole orchards in the worst infested districts has been not far from 45 per cent. This is based on many extended examinations in the open as well as on the cage experiment. It must be remembered that the insects in the cage were protected against birds, and to some extent against insect enemies.

In response to a request for information of Mr. James O. Read and Mr. C. M. Allen, as to the amount of loss at Missoula in the

summer of 1901, we were informed that 60 per cent. was destroyed but this probably applies to a few of the worst infested orchards. Enough is known to convince us that the situation is serious.

We consider birds to be great destroyers of these insects, since we have found very many cocoons from which they have removed the larvae or pupae. Therefore in the open orchards of the state where birds would be less disturbed, and where, also, there could be fewer places in which the larvae might construct their cocoons, than in the city yards where fences and other material furnish suitable protection, the loss would be much less, probably seldom, if ever, above 35 per cent. for whole orchards.

Along the valley of the Yellowstone river from Big Timber to the eastern boundary of the state, and south of this line, the moth could be very injurious. In the same zone, the upper sonoran, the states to the west of Montana, under normal conditions, as high as 100 per cent of the apples are damaged where no protective measures are employed. Mr. C. B. Simpson has recorded\* having found ten holes in a single apple, and the remains of twenty-three eggs on one apple and seventeen on another from orchards with but a little fruit. We may take these statements as indicating the possibilities of injury in the same zone in our state.

#### HOW THE CODLING MOTH SPREADS.

Undoubtedly the most common means of spread of the moth over long distances is in fruit packages. It is not strange that this insect has extended itself to almost every fruit growing region of the world, for when we analyze horticultural and commercial practices, we find a chain of conditions almost perfectly adapted to its spread.

Along with the development of a new agricultural country, apple growing naturally follows. Young trees are brought to the new country, planted, and cared for until they begin to produce fruit. In the meantime the public demands apples, and the merchant supplies them, making use of the surplus crops of other regions. With the imported apples are brought the insects which were in fruit with the larvae when it was picked from the trees. These larvae on reaching

\*Bulletin 30, New Series, Div. of Entomology. U. S. Department of Agriculture, 1902.

ing full growth crawl out of the fruit, and go in quest of a place to their liking in which to spin the cocoons which they occupy during the helpless pupa stage. The desired place is often found in an angle of the box or barrel, or under a cleat or beneath a board that has sprung in the freight car. From these points they may get to the orchard in various ways. The packages may be stored in the cellar for the winter, or until they are distributed, and the moths developing in the spring fly out of the open windows and doors and seek the fruit trees. Empty fruit packages are often thrown out behind back buildings, sometimes close by fruit trees. The writer once found an apple box in a back yard in Bozeman, and on picking it up found a number of cocoons of the codling moth in the corners. Within thirty feet was a small orchard of apple trees. The chances were favorable for the moths to colonize the orchard.

On leaving the fruit the larva often forms its cocoon in some material entirely separate from the fruit package. The writer has found the cocoons by the hundreds in freight cars recently unloaded of fruit. We are informed by Mr. Estey of Bigfork, that the heart of the main colony of the moth in Kalispell is within 100 yards of the side track of the Great Northern railroad. It is very probable that this colony was started from a car on the track. This car might have been unloaded of its fruit in almost any state in the country and yet have been the source of infection at Kalispell for the moths would leave the car wherever it might be when warm weather had completed their development, and meantime the car may have been transferred hundreds of miles. In the commission houses of our cities, as well as in the warehouses of our grocery stores, apple boxes are often stacked up parallel with many other kinds of produce such as boxed canned goods, packages of vegetables, melons, etc. The larvae may, and doubtless do, go to these other packages to pupate.

The practice of buying empty fruit boxes of the merchants in town and taking them to the orchards to be refilled is a particularly dangerous one, since the insects if present, are taken direct to the spot where they are most to be feared.

The codling moth is not distributed on nursery stock unless it is through mere accident.

From the foregoing it naturally follows that the centers of population are the first places to contract this pest. The towns then become centers of distribution for the surrounding country. Being provided with wings the moths can spread by flight, but it is probable that by this means they do not travel far.

One moth of either sex is incapable of starting a colony, but those in one fruit box may be sufficient since a box often contains a score or more cocoons.

#### WHAT BESIDES THE APPLE DOES THE MOTH ATTACK?

It is well known that the apple is the principal fruit injured by the codling moth. Pears are affected, but to less extent. Crab apples, quinces, wild haws, stone fruits, rose hips, and the scrub bean, (*Strombocarpa monocca*) have also been reported by various authors, but Mr. Simpson in his paper, previously mentioned, states that upon investigation it was found that in every case reported attack upon stone fruits, the work had been found to be that of the peach twig borer. Mr. Simpson also examined a large number of quinces and roses without finding a single case of infestation. Notwithstanding these facts it seems possible that the codling moth might lay its eggs on some other of the rosaceous fruits if unable to find any of its favorites and might possibly develop to maturity. The writer hopes to be able to give some definite information on this point in a future paper.

#### ANOTHER INSECT DOING SIMILAR WORK.

On August 28th, while on the trip up the valley of the Big Lost River, in company with Mr. Brandegee, as previously mentioned, the writer found a single apple in a poorly kept orchard about a mile north of Lo Lo, which upon first examination seemed to be beyond question, affected by the codling moth. The apple was yellow transparent and showed on its side the characteristic appearance of the entrance opening of the codling moth. Though the apple was examined closely when picked, there was not the slightest doubt in the mind of the writer that the work was that of the "apple worm." On cutting open the apple later, the appearance was entirely different from that expected. The larva had

left but had made a fine caliber burrow which was very long and tortuous and did not reach the core. It can be said with almost certainty that the work was not that of the codling moth.

### DISCRIPTIONS AND LIFE-HISTORY.

The larva having completed its growth in the fall of the year, leaves the fruit and goes in search of a place in which to spin a cocoon about itself. By searching in infested orchards about the trunks of trees that bore fruit the previous season, in the crotches and under scales of bark, the cocoons may be found. To some extent, they conform to the shape of the crack or crevice in which they are placed, being often much flattened.

With their mandibles the larvae digs off pieces of bark, thereby hollowing out the cavity and using in the cocoon the bits of bark together with the threads they spin from the body. Thus the cocoon is made to conform in color to its surroundings which is doubtless some protection against natural enemies. Many cocoons are made in objects entirely foreign to the fruit trees, as in fences, old rubbish, or any other material near at hand suitable for their purpose. They have been known also to enter the soil to pupate. Some of the men employed to scrape the trees at Missoula in the spring of 1902, reported that they had found cocoons on the trunks of poplar trees near the apple trees. While there is chance for mistaken identity of the insect in this case, there is no reason why the report may not be true.

In the cocoon the insect passes the winter as a larva, changing to a pupa with the warm weather of the following spring.

### THE PUPA.

The pupa is brownish in color, is five-sixteenths of an inch in length and has no appendages. After two or three weeks, when the insect is ready to emerge as a moth, it wriggles part way out of the cocoon and splits on the back. The moth crawls out leaving the empty pupa skin still protruding from the cocoon.

### THE MOTH.

The moth is a beautiful little insect with the fore wings marked with many gray and brown cross lines. Dark brown spots and streaks of orange or gold occur on the posterior end of the wings. The hind legs are grayish brown. Many of the moths caught in

the orchard are very badly rubbed and do not have the markings here mentioned. There are other species, that, to one unfamiliar with insects, might be mistaken for it.

### THE EGG.

The egg is not far from hemispherical in general shape but the edges flattened out. When examined from above or obliquely it seems much flattened, and appears hemispherical only when seen in profile. It is milk white in color.

### EGG LAYING.

The moths from the winter cocoons deposit the eggs which produce the first brood of larvae. The writer's observations agree with those of other persons who state that the eggs are laid both on the leaves and on the fruit. Throughout the season more eggs were found on the fruit than on the leaves.

While in Missoula, on October 4th, the writer was fortunate enough to see a moth deposit an egg on an apple. This occurred at 5:40 p. m., the sun being slightly above the horizon and shining brightly on the town. Within fifteen minutes after seeing the egg deposited, a thermometer was found and read at 68 degrees F.

The writer was approaching close to the outer and lower branches of an apple tree and saw a codling moth flying about the leaves and fruit in a very purposeful manner. An apple was selected and apparently without any regard for position on the fruit she stopped and arched the abdomen down, bringing the ovipositor against the skin. These steps were distinctly seen, but at this point the moth took fright and flew away, going one-third the way around the tree, settling down and secreting herself in a slightly curved leaf. In about one minute she started out again of her own accord, resuming her purposeful search. She lit upon an apple and at once arose again, flying higher in the tree, still searching. As she approached an apple with the calyx end turned toward her, she lit upon it, immediately turned one-quarter way round, and backed down into the depression around the calyx where the extremities of the wings touched the opposite side. She remained motionless for about thirty seconds, and flew away to another part of the tree and continued the search. The writer then climbed into the tree, picked the apple and found the freshly

egg in precisely the spot expected. It was about one-fourth of an inch from the calyx. The apple bearing this egg was brought to Bozeman, and lay on the writer's desk until the morning of the 16th of October, when the egg had hatched and the young larva was found crawling over the surface of the apple.

Many observers have stated that the eggs are laid at night time. We have made no observations on the point except the one above recorded. In view of what had been written we were surprised to find the moth laying so early in the evening. The sun had just left the top branches of the tree.

One egg or many may be laid on an apple. As we have already stated Mr. Simpson has found as high as 23 eggs on one fruit.

#### DURATION OF EGG STAGE.

Direct observations of various writers have brought out the fact that the duration of the egg stage varies with the temperature and is on an average about seven or eight days. They have been known to hatch as quickly as three days. The single egg discussed by the writer, hatched in practically eleven days; but the conditions were not normal since the egg was kept in doors.

#### THE LARVA.

The newly hatched larva is about one-sixteenth of an inch long, whitish in color, with the head, a shield just behind it and a shield at the posterior end of the body, black. Later in its life, the parts that were first black, become brownish.

The young larva after a short period on the surface of the apple, begins to bore into the flesh. The greater part go in at the calyx end, but many enter at the point where two apples touch or where a leaf is in contact with an apple. Others go in at the stem end, or on the exposed surface.

Judging from observations in the states to the west of Montana, the larval stage in Montana would be about 24 days. The writer has made no complete observations on this point, but can state definitely that it is less than four weeks.

The last published records of Mr. Simpson showed that an average of 83 per cent. of the first brood go into the fruit from the calyx end. From one counting at Missoula in 1902, the writer found 90 per cent. to enter at this point.

The course of the larva in the fruit is more or less familiar all. It bores direct to the core and feeds there on the seeds and flesh, making an irregular cavity which sometimes extends some distance from the core. The filthy frass is cast out of the opening on the surface, and remains there, matted together by the silken threads, until the larva pushes it off in leaving the fruit.

The larvae of the first brood, as well as those of the second, spin cocoons in which to pupate. The cocoons constructed by the first brood larvae are said to be thinner and less substantial than those in which the larvae pass the winter. The moths produced from the first brood larvae deposit the eggs for the second brood.

### THE OUT-OF-DOOR CAGE AT MISSOULA.

Realizing that a knowledge of the life-history and habits of this insect is basic to all rational measures against it, whether remedial or preventive, an attempt was made to gather all the information possible along these lines. The information gained thus far, while of considerable value, is in nowise complete. We hope to continue the studies as long as results of economic value are produced.

For the purpose of affording an opportunity for study of the habits of the moth under normal conditions in Missoula a cage was made enclosing an entire tree. This cage is twelve feet square and twelve feet high, and is constructed of medium quality lumber and wire mosquito netting. Along the square from corner to corner a wide board was settled into the earth with the edge exposed above the surface, to which is fastened the netting. The door shuts against packing and is held close by buttons. Outside the cage is a thirteen stranded barbed-wire fence which is angled at the top making it fairly proof against boys. The door and gate through the wire fence are kept locked.

Repeated comparison of the temperature inside and outside the cage failed to show any constant difference.

The details of the experiment and the results are mingled with the discussions that follow.

### DISCUSSION ON THE NUMBER OF BROODS, ETC.

On May 31st, eighteen cocoons and two moths were placed in the cage at Missoula. The cocoons for this purpose were secured

from Professor A. B. Cordley, who kindly arranged to have his students collect them for us. We are aware that there is a possibility that the results might be considered less reliable than if the insects had been secured locally. However, it was planned to continue the experiment for a number of years and we believe that in the future the results will be reliable.

Moreover the closest examination failed to reveal any difference in forwardness of development inside and outside the cage. In all probabilities the insects placed in the cage lay dormant until those outside began to develop, and developed parallel with them.

Missoula is 222 miles west of Bozeman on the line of the Northern Pacific railroad, and on account of the distance, trips to the cage were not very frequent, but by carefully timing the visits and by use of local assistance much information was obtained.

On June 18th one egg was found in the cage and a number more on various trees outside. Many of the moths had come out, but not all.

On July 10th, the occasion of the third visit, all the moths had emerged and three young larvae were found just beneath the skins of the apples. Eggs were fairly common. A few very badly rubbed moths were found, which, though of the correct size for the codling moth, may have been some other species. The insects were also found plentifully outside of the cage, either in the egg stage or having been in the fruit a few days.

On August 8th, 9th, and 10th, the larvae were coming out of the fruit. Some had evidently come out a few days earlier and some of what appeared to be the first brood were still in the apples. These ranged all the way from half grown to full sized larvae.

On August 11th many cocoons were found in the open orchards and about one-half of the larvae had pupated. Two empty pupa cases were found protruding from cocoons, and fresh looking adult moths. A few newly hatched larvae were seen.

We believe that about August 10th marked the beginning of the second brood of larvae.

On August 27th, insects were found in all stages, but it was noticeable that there were fewer moths and inhabited cocoons than on August 10th. As later developments show there were

many larvae in the fruit at this date but there were few outward indications. One might almost have thought that the trees were practically free from moth.

On October 5th, the appearance was very different. Many wormy apples vacated by the larvae were in evidence. The second brood of larvae had plainly left the fruit, though a few were to be found still feeding.

It was on this date, as previously stated, that the moth was seen to deposit the egg. Six other eggs were found in the same orchard this date without difficulty, and a number of moths were seen. We are inclined to consider these late moths as stragglers of the second brood.

To summarize, we may say that at Missoula in the summer of 1902 there were two broods of the codling moth and probably no more. The first brood began to go into the fruit about the 18th of June, and the second brood about August 10th.

#### RECOMMENDATIONS.

It would be out of place in the present paper to enter a lengthy discussion of the most approved means of combating the codling moth, for the general public is not yet called upon to employ such means.

Such protective measures as may be employed to enable us to retain our present advantage over the moth may well be considered.

It is desirable to continue the work at Missoula in order to keep at a minimum the chances of infection of the surrounding country and the valleys of the Bitter Root river and Rattlesnake creek. The situation at Kalispell should also be thoroughly looked into and as energetic means employed there as at Missoula.

We believe that since we know when the different broods begin to enter the fruit at Missoula, we can make good use of insecticides. Much advantage could be gained by again banding the trees. Much good was accomplished with bands during the past season. In this way many of the insects that escaped the poison were captured.

We recommend the use of Paris green as an insecticide with the usual addition of lime.

On August 23rd, an apple tree was selected from the Experiment Station orchard at Bozeman, and sprayed with a Bowker preparation of arsenate of lead at the rate of three pounds to fifty gallons of water, which is the strength recommended by the Bowker Insecticide Company.

The application was made personally by the writer and care was taken to spray thoroughly and yet not over spray.

At the time of fall harvesting, the apples were picked and part of them handed over to the Station chemist, Dr. F. W. Traphagen, to be tested for arsenic. Before harvesting considerable rain fell. Below is the report that Dr. Traphagen made:

PROF. R. A. COOLEY,

Montana Experiment Station, Bozeman, Mont.

DEAR SIR: Following are the results obtained in the analysis of the apples you submitted to me some time ago:

Number of apples.....	14	.
Total weight.....	41.5 oz.	
Average weight.....	3.0 oz.	(scant)
Total lead arsenate obtained from apples..	.166 grains	
Equivalent to metallic lead.....	.115 grains	
Equivalent to arsenic oxide.....	.031 grains	

While the amounts of poisonous substances found on these apples is not great, they are probably dangerous, from the fact that lead is a cumulative poison and that the presence in food or water of relatively smaller qualities than that present in these apples, is looked upon with grave suspicions by those who have given these questions careful consideration.

The arsenic, occurring in smaller quantities, adds also to the element of danger which would be introduced into our daily lives by using arsenate of lead for spraying apple trees under the condition of your experiment.

It seems to me that the amount remaining upon the apples could be very greatly reduced by spraying at an earlier period, when the apples were small or even when in the bud.

Experiments on spraying at different periods would seem to be indicated by results obtained in these tests.

Yours truly,  
F. W. TRAPHAGEN.

The writer was somewhat surprised to get this report of possible danger from the use of arsenate of lead and we intend to make more extended investigations.

One of the advantages of arsenate of lead over Paris green as an insecticide, is that it forms a film of the poison over the fruit and foliage that is not easily removed by rains. It has been found that this would be particularly useful against the codling moth since the eggs hatch and the larvae enter the fruit over such a long period of time. Uniform success has attended its use in some of the eastern states.

We still feel that early spraying with arsenate of lead would be more desirable than with Paris green.

We are indebted to Professor M. J. Elrod of Missoula and H. B. Dick of Kalispell for weather records that have been of great value to us in our work.

BULLETIN No. 43, ✓

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MONTANA AGRICULTURAL  
**Experiment Station,**

— OF THE —

**Agricultural College of Montana.**

**UTILITY OF WATER IN MONTANA.**

THIS PUBLICATION IS THE SECOND OF A SERIES OF FARMERS'  
BULLETINS ON IRRIGATION TOPICS.

**Bozeman, Montana, January, 1903.**

REPUBLICAN,  
Bozeman, Montana,  
1903.

1936

# MONTANA AGRICULTURAL Experiment Station

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## MONTANA EXPERIMENT STATION,

**Notice.**—The Bulletins of the Station will be mailed free to any Montana who sends his name and address to the Station for that purpose.

# Montana Experiment Station.

BULLETIN NO. 43.

JANUARY, 1903.

## DUTY OF WATER IN MONTANA.

BY S. FORTIER.

### INTRODUCTION.

This is the second of a series of farmers' bulletins on irrigation topics.

The results herein summarized, together with additional information which will appear in subsequent publications, represent the joint efforts of the Office of Experiment Stations of the Department of Agriculture and this Station. The funds required to carry on the work have been obtained from the State of Montana, the Department of Agriculture and this Experiment Station.

The general features of all the irrigation investigations conducted by this Station during the past four years have been ably planned and supervised by Professor Elwood Mead. During the past season Mr. Arthur P. Stover, an assistant under Professor Mead, was in direct charge of much of the field work. The writer desires also to acknowledge the valuable assistance rendered in both field and office by the senior students in civil engineering of the Montana Agricultural College.

### DUTY OF WATER.

The word "duty" is used in a variety of ways. In irrigation it shows the relation between the amount of water used and the area of land on which it is applied. This relation may be expressed in several ways. The units most frequently used are a miner's inch of water and an acre of land. The duty of water may be high or low, depending on the quantity used on a given area. In Southern California, where water is costly, one miner's inch irrigates on an average

five acres of land. This is considered a high duty, and is reasonable possible by preventing waste and in skillful use. In certain sections of Montana and the Rocky Mountain States the duty of water is one inch per acre. This large amount of water is frequently required for new land with a dry subsoil. When, however, this amount is used on the same fields for fifteen or twenty seasons in succession, it is found that a large percentage is wasted.

The duty of water may also be expressed in cubic feet per second and acres. In 1890 the legislative assembly of Wyoming fixed the maximum amount of water that could be legally applied in irrigation in that state by providing "That no allotment shall exceed one cubic foot per second for each seventy acres of land." From 1890 to the present the duty of water under the Bear River Canal system in Northern Utah was one cubic foot per second for each eighty-acre tract. This duty corresponds to one Montana miner's inch for two acres.

In the opinion of the writer, there is a better way to express the duty of water than by either the miner's inch or the cubic foot per second. By both of these methods one is left in doubt as to the volume of water actually applied. In both, the flow of the irrigation stream is assumed to be continuous, and the amount of water used will depend quite as much on the length of the irrigation season as on the size of the tract. Fifty miner's inches flowing for eighty days is equivalent in duty to one hundred miner's inches flowing for forty days. It is obvious that the length of the irrigation season must be fixed before the duty can be ascertained. It seldom happens that water is applied for the same number of days in any two counties, or even in the same county, hence the difficulty in ascertaining the duty when it is expressed in acres, per miner's inch or cubic foot. The better way, it seems to the writer, is to determine the quantity of water applied to a particular field, farm or district.

Rainfall is measured in depth over the surface on which it falls, and since irrigation is intended to supplement the natural rainfall, there is no good reason why it should not be measured in the same manner. Rain and snow are usually measured in inches, and in expressing duty of water the foot and fractions of a foot are used.

instead. When the quantity of water used is stated, it is expressed either in feet over the surface or in acre-feet. An acre-foot is that amount of water which will cover an acre to the depth of one foot. In Montana the average rainfall during the crop growing season is over six inches. We will assume that twenty-four inches is added by human effort, making a total of thirty inches, or two and one-half acre-feet. This is considerably greater than the natural supply of the humid East during the summer season.

### **ASCERTAINING THE DUTY OF WATER.**

At first thought, it seems easy to ascertain the duty of water. Only two things are necessary—the area of land irrigated and the amount of water applied. In actual practice it is not so easy. The flow of the irrigation stream, ditch or canal fluctuates—it is seldom the same for any two consecutive hours of the day. This necessitates constant observations at the place of measurement or the introduction of scientific apparatus which will record every change in volume. Then again, much depends on where the water used in irrigation is measured. If it were conveyed in a tight pipe, there would be no loss, and the amount entering the intake would correspond with that delivered at the lower end. Usually the water is conveyed in an earthen channel, and for every hundred miner's inches diverted from the natural stream, only sixty may be delivered, the remaining forty inches being lost along the route by seepage, evaporation and leakage. In the results herein given, the duty of water under the canals was found by measuring the amount of water which passed through the headgates. On each of the field tests, the water was measured as it entered the highest part of the field. The latter averaged about eighteen inches in depth over the surface, while the former averaged nearly forty-seven inches.

### **CONDITIONS AFFECTING DUTY OF WATER.**

It is well known that the amount of water used in irrigation differs. One-half of a quarter section of land may require much more water than the other half. No two irrigated valleys within the borders

of a state have similar physical conditions, and each arid territory, has its own peculiar characteristics as regards water irrigation. In a practical publication of this kind it may not of place to outline briefly the chief conditions which affect the water:

(1) **LOSSES IN CONVEYANCE.**—The quantity of water delivered to the farmers is frequently only one-half that taken from the source. The various losses due to seepage, evaporation and leakage in the canal and laterals cause this large reduction. The attention of the farmers of Montana is earnestly called to this fact on account of the large financial loss entailed. The writer does not wish to imply that all of this loss can be prevented, but he is convinced that a large percentage might be saved at comparatively small cost.

(2) **CLIMATIC CONDITIONS.**—Of these, rainfall is perhaps the most important. The average annual precipitation for Montana is between fourteen and fifteen inches. The months of greatest precipitation are April, May and June, the period when moisture is needed to start crops. In the following tables it will be noticed that the precipitation varies from  $1\frac{1}{2}$  to  $9\frac{1}{2}$  inches and averages  $5\frac{1}{2}$  inches. This amount of moisture in the case of the field tests forms on an average 50 per cent of the total amount of water applied to the crops.

In the colder arid states the season is shorter and irrigation is practiced only a short period in summer; while farther south, for example in Arizona, water for irrigation may be used throughout three-fourths of the year. Then, too, evaporation is affected by temperature, wind, etc., and in a region of high temperatures, or high winds, or both, the consequent loss of water by evaporation is large.

(3) **DIVERSIFIED FARMING.**—A farmer whose cultivated crops are confined to such cereals as oats, wheat and barley cannot make the most of his water supply. Such crops may require a large amount of water from the time the plants cover the ground until the grain is well headed out, but this period is limited to from thirty to fifty days. The man who raises grain only has no further use for irrigation during that season. When diversified crops, such as alfalfa, clover, grain, roots and fruit are grown it is possible to increase the

without increasing the amount of water used, and so obtain a higher yield.

(4) **TIME ROTATION.**—The prevailing custom in several states and territories of the arid West is to apportion water by the time method instead of in continuous streams. In the case of small holdings in particular, water can be more economically used in a proper system of time rotation. The work can be better done and at less cost than where a small stream is used continuously.

(5) **MANNER OF PAYING FOR WATER.**—A canal corporation, which conveys water to distribute to farmers for a fixed rental usually sells a water right for a certain tract of land. The purchaser, by the terms of his contract is compelled to use his allotted share of water on the tract for which a water right has been purchased and not elsewhere. If the user were granted permission to buy water by volume from the canal company and to use it wherever he pleased a much greater economy in its use would result.

(6) **JUDICIAL DECREES FOR EXCESSIVE AMOUNTS.**—For the most part the volumes of water used in irrigation are unknown. As a rule new ditches or canals are measured until after the owners are threatened with litigation. Then there is great inducement for all parties concerned to try to magnify both the amount diverted and the extent of the land irrigated. When a witness does not know the capacity of a ditch, and it is to his interests to make it appear to be large, his testimony has usually a decided bias in that direction. When no reliable measurements of ditches have been made, water right cases can only be decided on the testimony submitted and this accounts for the many recorded cases in which excessive amounts have been decreed.

(7) **CULTIVATION AND GRADING.**—The proper cultivation of the soil is necessary, in both humid and arid climates. Cultivated plants require a finely pulverized soil. In regions deficient in rainfall, thorough cultivation serves to retain the moisture, by lessening the amount of evaporation. Grading is even more important. To irrigate land that has a rough, uneven surface, not leveled to a uniform grade, is frequently the cause of much waste of water, extra labor, small crops and eventually damaged land.

(8) **KIND OF CROP.**—The proper percentage of moisture soil does not differ much for the common cultivated plants. Some crops require more water than others but this difference is due to a longer period of growth or to the time when water is needed. Barley, for instance will mature in three and one-half months, sugar beets require a month longer. Again it is often difficult to obtain sufficient water to irrigate root crops, vegetables and occasionally orchards. This does not arise from the fact that a larger supply is required but it is due to the time of irrigation, the last irrigation being usually applied late in the season, when the flow of natural stream is low.

(9) **MANNER OF IRRIGATING.**—The duty of water depends to a great extent on the skill and attention of the irrigator as well as on the way it is distributed over the field. Where flooding is practiced, the duty depends on the location and grade of the field laterals as well as the direction of the seed drills. In Montana a large percentage of the water conveyed to the irrigated fields is wasted in the midnight hours when there is no one to look after it.

(10) **CHARACTER OF THE SOIL AND SUBSOIL.**—A coarse sandy or gravelly soil requires much more water than a heavy, clay soil. If the upper layer is porous and the subsoil impervious, the conditions are favorable for sub-irrigation in which case a small amount of water may irrigate a large area. On the other hand the top layer of soil may be underlaid by gravel wash. Such formations require an abundant supply of water.

(11) **THE GROUND WATER LEVEL.**—In some localities the water in wells will rise near the surface during the latter part of the irrigation season. This indicates that the subsoil is completely saturated so that the minimum amount of water should be applied in irrigation. To over-irrigate such tracts would result in damage to both crop and soil.

(12) **THE CONFIGURATION OF THE SURFACE.**—An even uniform slope, neither too steep nor too flat, is one of the most favorable conditions for the economic use of water. Tracts that are traversed by ravines or other irregular formations, are not only difficult to irrigate but the waste of water is usually considerable.

## THE IMPORTANCE OF A KNOWLEDGE OF THE DUTY OF WATER.

A knowledge of the service or duty of water is necessary in all irrigated regions. It has always been regarded as one of the essentials of irrigation. As rural communities increase in population the extent of the cultivated area is also increased, new ditches are excavated and the capacities of old channels are enlarged until a time comes when the natural streams are overtaxed and disputes arise as to the rights of each claimant. Such controversies can only be settled on the amount of water required to mature crops.

The farmer knows how much seed to sow for each kind of crop. He should also know how much water to apply. Without this knowledge farming operations cannot be economically planned or carried on. The farmer who buys 100 miners' inches from a canal company, but is ignorant of how many acres this supply will irrigate is handicapped.

When farmers unite in co-operative undertakings, the location, extent and character of the land to be reclaimed are usually familiar to all. The puzzling questions to such parties are the amount of water required and the size of the ditch to convey it. The same problem confronts the officers of the large capitalistic canal. The expenditures may be large and an error in the estimate of the amount of water required may entail heavy losses.

In the near future the Federal Government will expend in all probability, several million dollars in this state on irrigation canals and storage reservoirs. In such large enterprises the area of land which a standard unit of flowing water will irrigate is one of great importance.

And finally, without a knowledge of the duty of water, it is impossible to determine equitably rights to its use. When a court, owing to a wrong conception of the quantity of water required, grants to an individual or corporation, three or four times more than he can use, it not only deprives other settlers of a much needed supply but the application of so much water tends to convert good land into bogs and marshes.

### AMOUNT OF WATER USED

In all of the experiments made to ascertain the duty of water, the

results of which are herein briefly recorded, no attempt was control or limit the amount used. The proprietor of the field or his employe, was free to turn on as much water as he considered necessary. A part of the supply usually flowed off the field otherwise wasted, but no deduction was made for this waste. The total amount entering the highest part of the field was measured by means of a trapezoidal weir or other device and the area under the surface including the space occupied by the feed ditches and laterals was surveyed in the ordinary manner. From this information the depth of water over the surface irrigated was ascertained. This depth of water over the surface in the 46 field tests varied from a trifle more than four inches (.35 feet) to over seventy-two inches (6.06 feet) and averaged 5.35 inches or one and one-half acre-feet per acre irrigated.

In Table No. 1, the duty is expressed in acres per miner's inch. The lowest duty was at the rate of one miner's inch per acre and the highest duty was one miner's inch for 13 acres. The average duty of the 46 experiments conducted on fields was at the rate of one miner's inch for 3.7 acres. In another column of the same table the duty is expressed in acres per cubic foot per second. The average duty was 142 acres irrigated per cubic foot per second was 142.

There is much more water used per acre under the canals than under the seven canals, the results of which are given in this publication. The combined area is 41466 acres and the average depth of water over this surface was 3.9 feet, or nearly 47 inches: Under the canals one cubic foot per second would irrigate about 80 acres and one miner's inch, 2 acres.

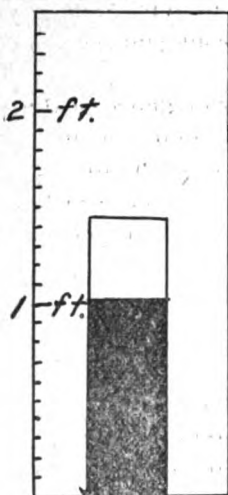
## TABLES AND ILLUSTRATIONS.

Space would not permit a description of each experiment. It was necessary to state the facts in the briefest possible manner. The chief results have accordingly been presented in the form of tables and statements. And since the main purpose of the bulletin is to show the amount of water used in irrigation it was deemed advisable to represent this quantity by diagram as well as by figures. In the 46 experiments conducted on fields there is inserted a small illustration to the left of the statement. This is drawn on a scale

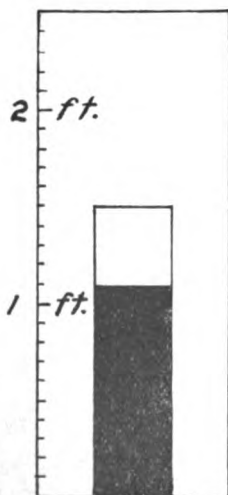
ch to the foot and shows graphically the quantity of water applied in irrigation as well as the rainfall. The dark portion represents the amount received in irrigation, the light portion, the amount received rainfall.

In experiment No. 1, for instance, the reader who glances at the diagram observes that more than two-thirds of the total amount of water received is from irrigation. If he wishes the exact figures, the statement shows that 1.02 feet, or  $12\frac{1}{4}$  inches, was spread over the entire surface of a 31-acre clover field and that the amount of rain which fell on the same surface during the period of growth was .44 feet, or  $5\frac{1}{4}$  inches.

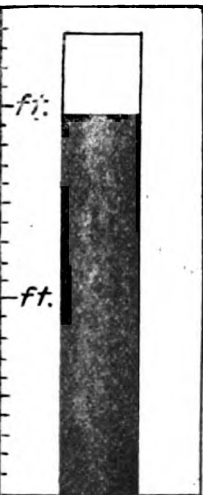
The duty of water under the canals for 1902 is illustrated by the plates, which are modeled after those in Bulletin No. 86, U. S. Department of Agriculture. The dark portion of the main illustration shows when the water began to be used, the daily amount and the end of the irrigation season. The smaller cut to the right shows the duty of water for each month as well as the rainfall for the same period.

**Experiment No. 1.**

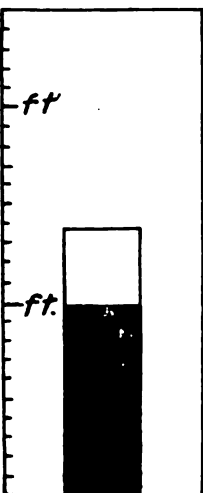
Location .....	Gallatin Valley.
Crop .....	Clover.
Yield per acre .....	3 tons.
Nature of soil .....	Clay loam.
Area .....	31 acres.
Date of first irrigation .....	June 17-22.
Date of second irrigation .....	July 26-Aug. 2.
Average head of water used .....	1.54 cu. ft. per sq. ft.
Depth of water applied .....	1.02 ft.
Rainfall .....	.44 ft.
Total depth of water received ..	1.46 ft.

**Experiment No. 2.**

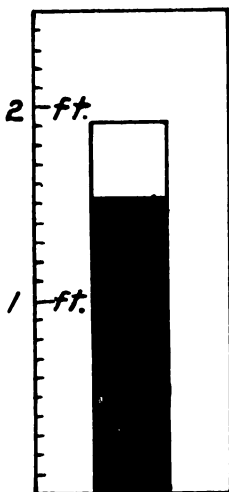
Location .....	Gallatin Valley.
Crop .....	Peas.
Yield per acre .....	31.25 bushels.
Nature of soil .....	Clay loam.
Area .....	4.23 acres.
Date of first irrigation .....	June 28.
Date of second irrigation .....	July 11-12.
Average head of water used .....	1.28 cu. ft. per sq. ft.
Depth of water applied .....	1.10 ft.
Rainfall .....	.41 ft.
Total depth of water received ..	1.51 ft.

**Experiment No. 3.**

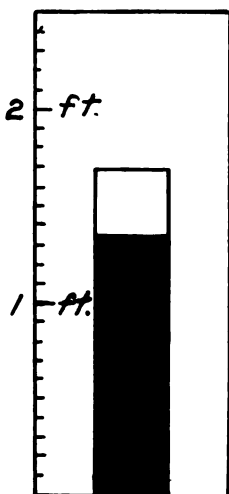
Location .....	Gallatin Valley.
Crop .....	Grain.
Yield per acre .....	57.89 bushels.
Nature of soil .....	Loam.
Area .....	11.27 acres.
Date of first irrigation .....	June 23-27.
Date of second irrigation .....	July 12-14.
Average head of water used ....	1.81 cu. ft. per sec.
Depth of water applied .....	1.98 ft.
Rainfall .....	0.42 ft.
Total depth of water received ..	2.40 ft.

**Experiment No. 4.**

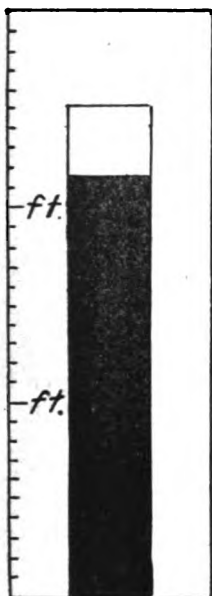
Location .....	Gallatin Valley.
Crop .....	Barley.
Yield per acre .....	73 bushels.
Nature of soil .....	Loam.
Area .....	66.39 acres.
Date of first irrigation .....	July 5-13.
Average head of water used ....	4.04 cu. ft. per sec.
Depth of water applied .....	0.98 ft.
Rainfall .....	0.41 ft.
Total depth of water received ..	1.39 ft.

**Experiment No. 5.**

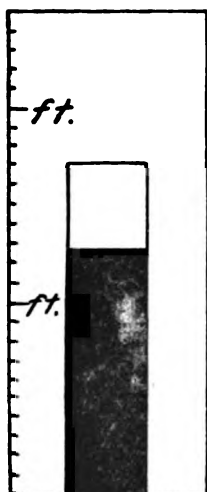
Location.....	Gallatin Valley.
Crop .....	Oats.
Yield per acre.....	51 bushels.
Nature of Soil.....	Clay loam.
Area .....	23.41 acres.
Date of first irrigation.....	July 13-18
Average feed of water used.....	3.54 cu. ft. per sec.
Depth of water applied.....	1.53 ft.
Rainfall .....	.38 ft.
Total depth of water received..	1.91 ft.

**Experiment No. 6.**

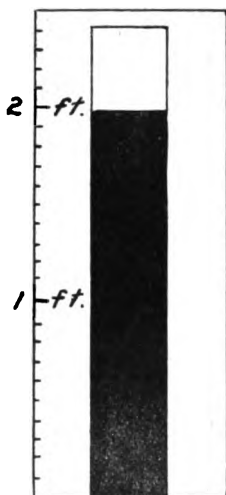
Location.....	Gallatin Valley.
Crop .....	Oats.
Yield per acre.....	72.75 bushels.
Nature of Soil.....	Clay loam.
Area .....	7.26 acres.
Date of first irrigation.....	July 6-7.
Date of second irrigation.....	July 22-24.
Average head of water used....	1.58 cu. ft. per sec.
Depth of water applied.....	1.34 ft.
Rainfall .....	.36 ft.
Total depth of water received..	1.70 ft.

**Experiment No. 7.**

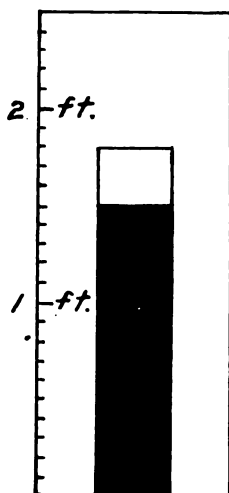
Location .....	Gallatin Valley.
Crop .....	Oats.
Yield per acre .....	72.75 bushels.
Nature of soil .....	Clay loam.
Area .....	2.48 acres.
Date of first irrigation .....	July 7-8.
Date of second irrigation .....	July 25.
Average head of water used....	1.96 cu. ft. per sec.
Depth of water applied .....	2.16 ft.
Rainfall .....	.36 ft.
Total depth of water received..	2.52 ft.

**Experiment No. 8.**

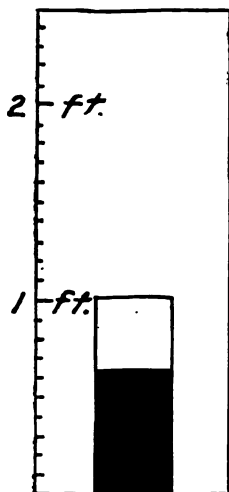
Location .....	Gallatin Valley.
Crop .....	Oats.
Nature of soil .....	Dark loam.
Area .....	25.09 acres
Date of first irrigation .....	July 20-26.
Average head of water used....	3.13 cu. ft. per sec.
Depth of water applied .....	1.28 ft.
Rainfall .....	.44 ft.
Total depth of water received..	1.72 ft.

**Experiment No. 9.**

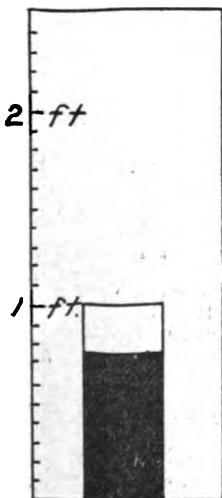
Location.....	Gallatin Valley.
Crop .....	Clover.
Nature of soil.....	Clay loam.
Area .....	66.39 acres.
Date of first irrigation .....	June 14-22.
Date of second irrigation.....	July 28-Aug. 17.
Average head of water used....	2.54 cu. ft. per sec.
Depth of water applied .....	1.98 ft.
Rainfall .....	.41 ft.
Total depth of water received..	2.42 ft.

**Experiment No. 10.**

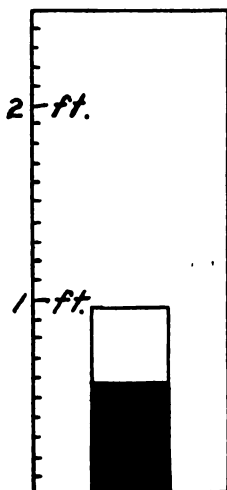
Location .....	Gallatin Valley.
Crop .....	Barley.
Yield per acre .....	46.5 bushels.
Nature of soil.....	Dark loam.
Area .....	4.14 acres.
Date of first irrigation .....	June 12-13.
Date of second irrigation.....	June 29-July 1.
Average head of water used....	1.24 cu. ft. per sec.
Depth of water applied .....	1.50 ft.
Rainfall .....	.28 ft.
Total depth of water received ..	1.78 ft.

**Experiment No. 11.**

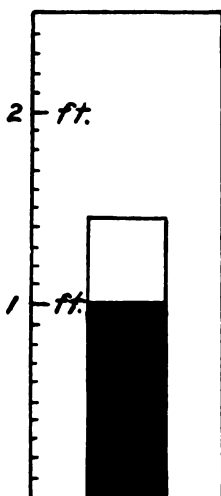
Location.....	Gallatin Valley.
Crop .....	Oats.
Nature of soil.....	Clay loam.
Area .....	25.09 acres.
Date of first irrigation.....	June 18-21.
Date of second irrigation.....	July 23-29.
Average head of water used....	1.40 cu. ft. per sec.
Depth of water applied.....	.64 ft.
Rainfall.....	.39 ft.
Total depth of water received..	1.03 ft.

**Experiment No. 12.**

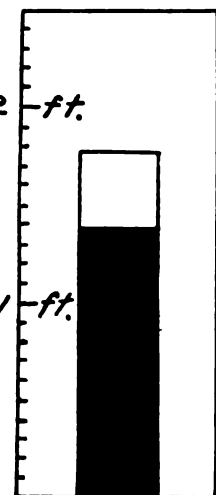
Location.....	Gallatin Valley.
Crop .....	Wheat and Clover.
Yield per acre.....	38.33 bu. 3,170 lb. clover
Nature of soil.....	Garden loam.
Area .....	2 acres.
Date of first irrigation.....	June 18.
Date of second irrigation.....	July 11-12.
Average head of water used..	1.40 cu. ft. per sec.
Depth of water applied.....	.77 ft.
Rainfall .....	.30 ft.
Total depth of water received..	1.07 ft.

**Experiment No. 13.**

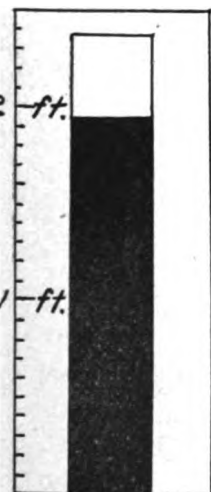
Location.....	Gallatin Valley.
Crop .....	Oats and Peas.
Yield per acre.....	75.58 bu. O. 1330 lb. P
Nature of soil.....	Loam.
Area .....	2 acres.
Date of first irrigation.....	June 18.
Date of second irrigation.....	July 11.
Average head of water used....	1.37 cu. ft. per sec.
Depth of water applied.....	.56 ft.
Rainfall.....	.39 ft.
Total depth of water received..	.95 ft.

**Experiment No. 14.**

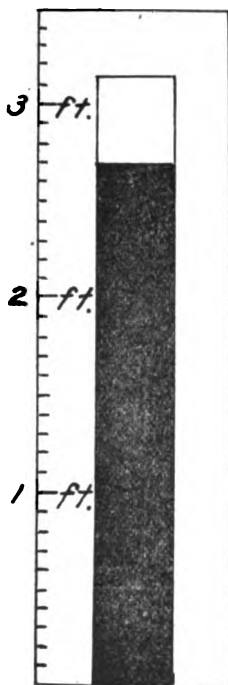
Location.....	Gallatin Valley.
Crop .....	Barley.
Yield per acre.....	87.29 bushels.
Nature of soil.....	Loam.
Area .....	1 acre.
Date of first irrigation.....	June 19.
Date of second irrigation.....	July 12.
Average head of water used..	1.38 cu. ft. per sec.
Depth of water applied.....	1.17 ft.
Rainfall .....	.28 ft.
Total depth of water received..	1.45 ft.

**Experiment No. 15.**

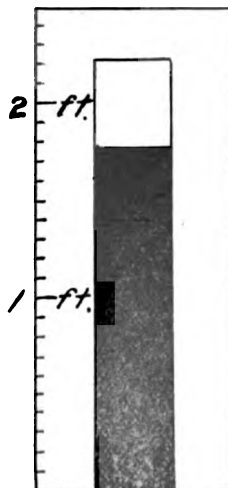
Location .....	Gallatin Valley.
Crop.....	Oats.
Yield per acre.....	74.67 bushels.
Nature of soil.....	Loam.
Area.....	8.51 acres.
Date of first irrigation.....	June 15-17.
Date of second irrigation.....	July 6-7.
Average head of water used....	1.86 cu. ft. per sec.
Depth of water applied.....	1.39 ft.
Rainfall.....	0.40 ft.
Total depth of water received..	1.79 ft.

**Experiment No. 16.**

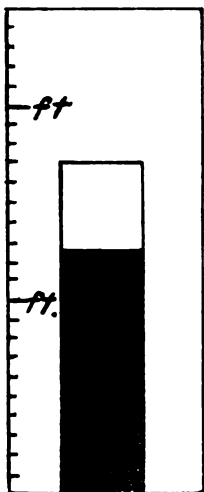
Location.....	Gallatin Valley.
Crop.....	Barley.
Yield per acre.....	68.59 bushels.
Nature of soil.....	Loam.
Area.....	4.52 acres.
Date of first irrigation.....	June 13 14.
Date of second irrigation.....	July 1-2.
Average head of water used....	1.99 cu. ft. per sec.
Depth of water applied.....	1.96 ft.
Rainfall.....	0.42 ft.
Total depth of water received..	2.38 ft.

**Experiment No. 17.**

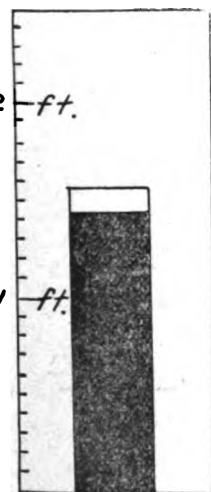
Location .....	Gallatin Valley.
Crop .....	Clover.
Yield per acre .....	5 tons.
Nature of soil .....	Clay loam.
Area .....	7.26 acres.
Date of first irrigation .....	June 4-5.
Date of second irrigation .....	June 3-5.
Date of third irrigation .....	July 19-21.
Date of fourth irrigation .....	Aug. 1-4.
Average head of water used .....	1.57 cu. ft. per sec.
Depth of water applied .....	2.70 ft.
Rainfall .....	.44 ft.
Total depth of water received ..	3.14 ft.

**Experiment No. 18.**

Location .....	Gallatin Valley.
Crop .....	Clover.
Nature of soil .....	Clay loam.
Area .....	35.9 acres.
Date of first irrigation .....	June 5-7.
Date of second irrigation .....	July 13-16.
Date of third irrigation .....	July 26-28.
Average head of water used .....	2.22 cu. ft. per sec.
Depth of water applied .....	1.79 ft.
Rainfall .....	.44 ft.
Total depth of water received ..	2.23 ft.

**Experiment No. 19.**

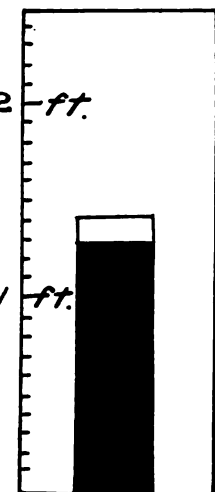
Location .....	Yellowstone County.
Crop .....	Alfalfa.
Yield per acre.....	5.17 tons.
Nature of soil.....	Clay loam.
Area irrigated .....	53.4 acres.
Date of first irrigation.....	July 17-27.
Average head of water used....	3.52 cu. ft. per sec.
Depth of water applied .....	1.30 ft.
Rainfall .....	.44 ft.
Total depth of water received..	1.74 ft.

**Experiment No. 20.**

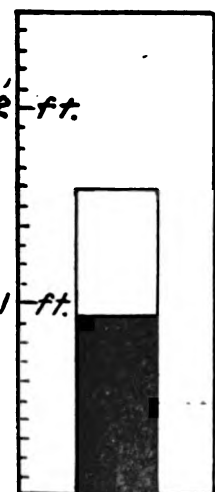
Location .....	Bitter Root Valley.
Crop .....	Orchard.
Nature of soil.....	Vegetable loam.
Area .....	40 acres.
Date of first irrigation.....	April 28-30.
Date of second irrigation.....	June 7-13.
Date of third irrigation.....	July 9-14.
Date of fourth irrigation.....	Aug. 12-14.
Average head of water used....	2.36 cu. ft. per sec.
Depth of water applied .....	1.46 ft.
Rainfall .....	.13 ft.
Total depth of water received..	1.59 ft.

**Experiment No. 21.**

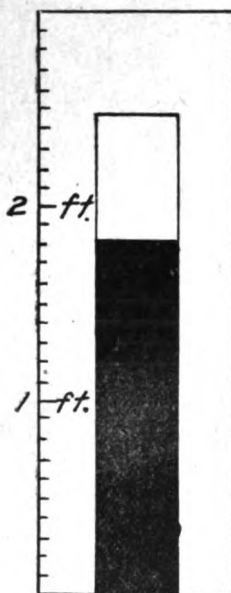
Location .....	Bitter Root
Crop .....	Oats.
Yield per acre.....	34.03 bushel
Nature of soil .....	Gravelly.
Area .....	102.2 acres.
Date of first irrigation.....	May 23-June
Date of second irrigation.....	July 19-Aug
Average head of water used....	7.05 cu. ft. p
Depth of water applied .....	6.06 ft.
Rainfall .....	.13 ft.
Total depth of water received..	6.19 ft.

**Experiment No. 22.**

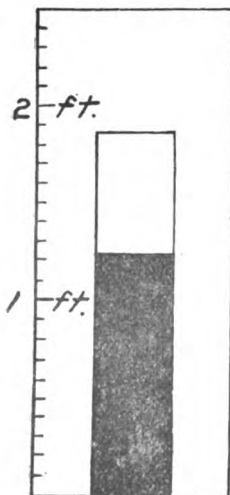
Location .....	Bitter Root Valley.
Crop .....	Oats.
Yield per acre .....	33.37 bushels.
Nature of soil .....	Vegetable Loam.
Area .....	161.7 acres.
Date of first irrigation .....	May 22, June 11.
Date of Second irrigation .....	July 21-30.
Average head of water used....	3.75 cu. ft. per sec.
Depth of water applied .....	1.30 ft.
Rainfall ..	.13 ft.
Total depth of water received..	1.43 ft.

**Experiment No. 23.**

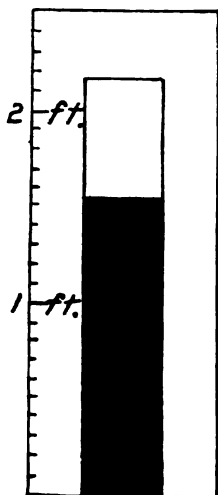
Location .....	Gallatin Valley.
Crop .....	Clover.
Yield per acre .....	3.36 tons.
Nature of soil .....	Loam.
Area .....	20.96 acres.
Date of first irrigation .....	June 5-7.
Date of second Irrigation .....	July 20-22, Aug. 2-7,
Date of second irrigation .....	Aug. 11-16.
Average head of water used....	1.52 cu. ft. per sec.
Depth of water applied .....	.92 ft.
Rainfall .....	.65 ft.
Total depth of water received..	1.57 ft.

**Experiment No. 24.**

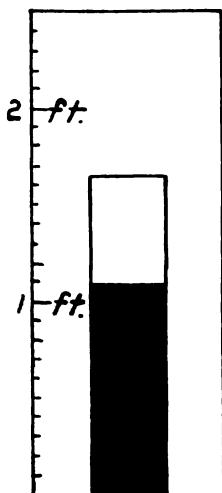
Location.....	Gallatin V.
Crop.....	Clover.
Yield per acre.....	3.36 tons.
Nature of soil.....	Clay loam.
Area .....	5.58 acres
Date of first irrigation.....	June 8.
Date of second irrigation.....	July 9-10
Date of third irrigation.....	July 25-29
Average head of water used....	1.38 cu. ft.
Depth of water applied.....	1.81 ft.
Rainfall.....	.67 ft.
Total depth of water received..	2.48 ft.

**Experiment No. 25.**

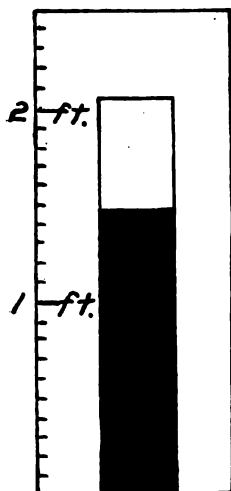
Location .....	Gallatin V.
Crop.....	Clover.
Nature of soil.....	Clay loam.
Area .....	7.13 acres.
Date of first irrigation.....	June 17-18
Date of second irrigation.....	July 14-15
Average head of water used..	1.65 cu. ft.
Depth of water applied .....	1.24 ft.
Rainfall.....	.62 ft.
Total depth of water received..	1.86 ft.

**Experiment No. 26.**

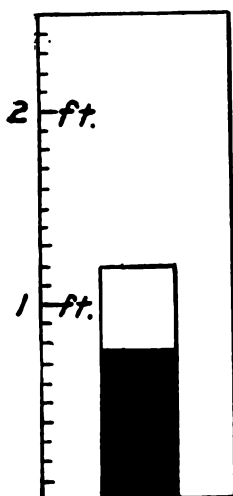
Location .....	Gallatin Valley.
Crop .....	Clover.
Nature of soil .....	Loam.
Area .....	6.85 acres.
Date of first irrigation .....	June 18-19.
Date of second irrigation .....	July 12-13.
Date of third irrigation .....	July 29-Aug. 6.
Average head of water used ....	1.40 cu. ft. per sec.
Depth of water applied .....	1.54 ft.
Rainfall .....	.62 ft.
Total depth of water received ..	2.16 ft.

**Experiment No. 27.**

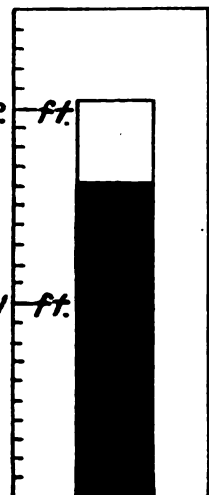
Location .....	Gallatin Valley.
Crop .....	Wheat.
Yield per acre .....	43.2 bushels.
Nature of soil .....	Loam.
Area .....	5.24 acres.
Date of first irrigation .....	June 27-28.
Date of second irrigation .....	July 13-14.
Average head of water used ....	1.47 cu. ft. per sec.
Depth of water applied .....	1.19 ft.
Rainfall .....	.45 ft.
Total depth of water received ..	1.64 ft.

**Experiment No. 28.**

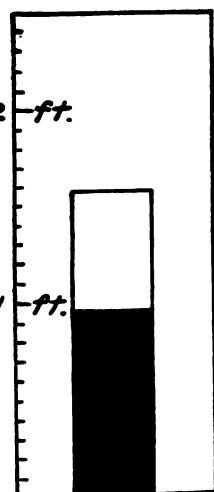
Location.....	Gallatin Valley.
Crop.....	Wheat, Barley, Clover.
Yield per acre.....	42.9bu 61.5bu 1.59 tons
Nature of soil.....	Clay loam.
Area .....	3 acres
Date of first irrigation.....	June 28-29
Date of second irrigation.....	July 15-16
Average head of water used....	1.23 cu. ft. per sec.
Depth of water applied.....	.76 ft.
Rainfall.....	.43 ft.
Total depth of water received..	1.19 ft.

**Experiment No. 29.**

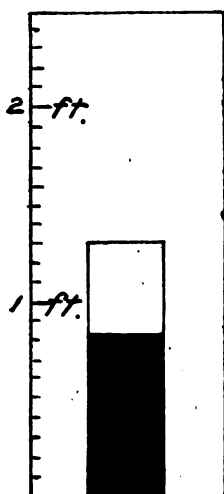
Location .....	Gallatin Valley.
Crop.....	Sugar Beets.
Yield per acre.....	10 ton,
Nature of soil.....	Clay loam.
Area .....	3 acres.
Date of first irrigation.....	July 13-14.
Date of second irrigation.....	July 29-30.
Date of third irrigation.....	Aug. 16-17.
Average head of water used..	.44 cu. ft. per sec.
Depth of water applied .....	1.46 ft.
Rainfall.....	.59 ft.
Total depth of water received..	2.05 ft.

**Experiment No. 30.**

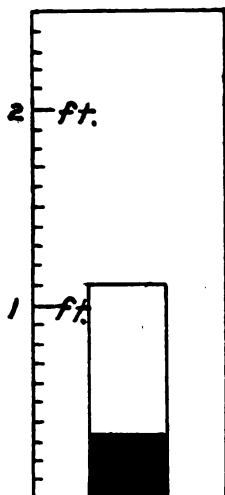
Location .....	Gallatin Valley
Crop .....	Oats
Yield per acre .....	73 bushels.
Nature of soil .....	Clay loam
Area .....	15.35 acres
Date of first irrigation .....	June 28-July 2
Date of second irrigation .....	July 16-17, July 22-25
Average head of water used....	1.68 cu. ft. per sec.
Depth of water applied .....	1.62 ft.
Rainfall .....	.43 ft.
Total depth of water received..	2.05 ft.

**Experiment No. 31,**

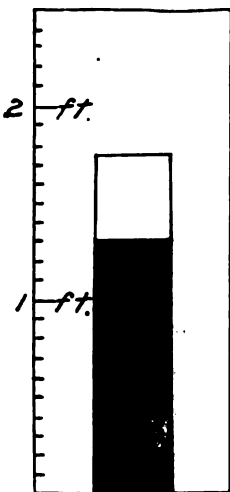
Location .....	Gallatin Valley
Crop .....	Clover.
Nature of soil .....	Clay loam.
Area .....	27.84 acres
Date of first irrigation .....	June 21-25
Average head of water used..	3.33 cu. ft. per sec.
Depth of water applied .....	.95 ft.
Rainfall .....	.62 ft.
Total depth of water received..	1.57 ft.

**Experiment No. 32.**

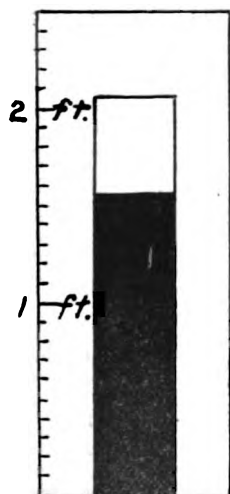
Location .....	Gallatin Valley.
Crop .....	Barley.
Yield per acre .....	59 bushels.
Nature of soil .....	Loam.
Area .....	12.5 acres.
Date of first irrigation .....	July 2-3, July 5-6.
Average head of water used ....	2.18 cu. ft. per sec.
Depth of water applied .....	.34 ft.
Rainfall ..	.46 ft.
Total depth of water received..	1.30 ft.

**Experiment No. 33.**

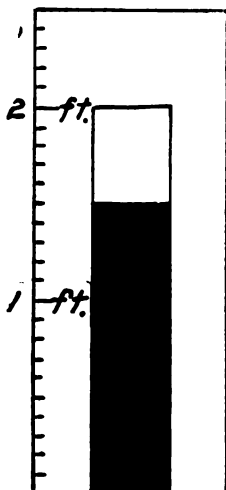
Location .....	Gallatin Valley.
Crop .....	Peas.
Yield per acre .....	37.5 bushels.
Nature of soil .....	Clay loam.
Area .....	8.40 acres.
Date of first irrigation .....	July 8-9.
Average head of water used ....	1.67 cu. ft. per sec.
Depth of water applied .....	.35 ft.
Rainfall .....	.77 ft.
Total depth of water received..	1.12 ft.

**Experiment No. 34.**

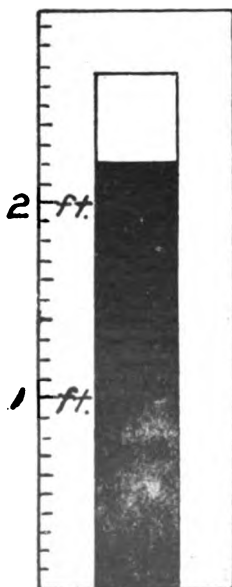
Location .....	Gallatin Valley
Crop.....	Oats
Nature of soil.....	Loam
Area .....	37.3 acres
Date of first irrigation.....	July 9-23
Average head of water used....	1.66 cu. ft. per sec.
Depth of water applied.....	1.26 ft.
Rainfall.....	.45 ft.
Total depth of water received..	1.71 ft.

**Experiment No. 35.**

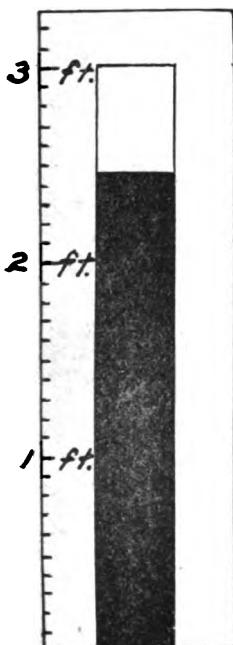
Location .....	Gallatin Valley
Crop.....	Orchard.
Nature of soil.....	Gravelly loam.
Area .....	40 acres
Date of first irrigation.....	April 15-18
Date of second irrigation.....	June 27-30
Date of third irrigation.....	Aug. 13-18
Date of fourth irrigation.....	Sept. 1-2
Average head of water used..	2.43 cu. ft. per sec.
Depth of water applied....	1.56 ft.
Rainfall.....	.49 ft.
Total depth of water received..	2.05 ft.

**Experiment No. 36.**

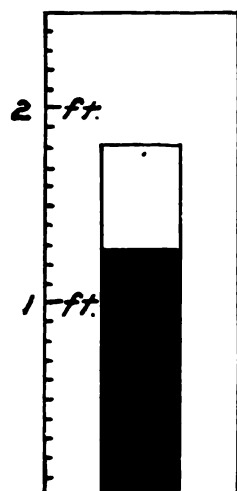
Location .....	Bitter Root Valley.
Crop .....	Clover.
Yield per acre .....	1.06 tons.
Nature of soil .....	Gravelly loam.
Area irrigated .....	161.7 acres.
Date of first irrigation .....	May 11-28.
Date of second irrigation .....	June 23-July 2.
Date of third irrigation .....	Aug. 29-Sept. 8.
Average head of water used ....	3.40 cu. ft. per sec.
Depth of water applied .....	1.50 ft.
Rainfall .....	.49 ft.
Total depth of water received..	1.99 ft.

**Experiment No. 37.**

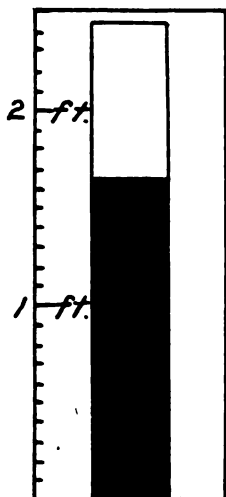
Location .....	Bitter Root Valley.
Crop .....	Clover.
Yield per acre .....	1 ton.
Nature of soil .....	Gravelly.
Area .....	102. acres.
Date of first irrigation .....	Apr. 20-May 2
Date of second irrigation .....	May 4-16, 21-30.
Date of third irrigation .....	June 11-July 3.
Date of fourth irrigation .....	July 29-Aug. 13
Average head of water used ....	4.01 cu. ft. per sec.
Depth of water applied .....	2.22 ft.
Rainfall .....	.45 ft.
Total depth of water received..	2.67 ft.

**Experiment No. 38.**

Location .....	Gallatin Valley.
Crop .....	Oats.
Nature of soil .....	Clay loam.
Area .....	5.38 acres.
Date of first irrigation .....	June 24-26.
Date of second irrigation .....	July 17-18.
Average head of water used....	1.30 cu. ft. per sec.
Depth of water applied .....	1.27 ft.
Rainfall .....	.54 ft.
Total depth of water received..	1.81 ft.

**Experiment No. 39.**

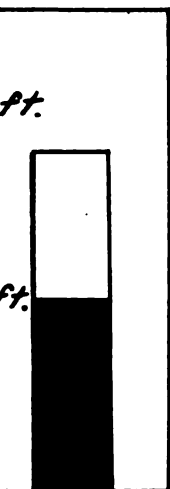
Location .....	Gallatin Valley.
Crop .....	Wheat.
Nature of soil .....	Clay loam.
Area .....	5.62 acres.
Date of first irrigation .....	June 22-23.
Date of second irrigation .....	July 25-31.
Average head of water used....	2.43 cu. ft. per sec.
Depth of water applied .....	2.43 ft.
Rainfall .....	.72 ft.
Total depth of water received..	3.15 ft.

**Experiment No. 40.**

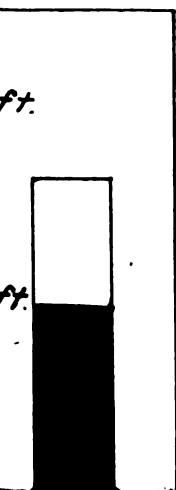
Location .....	Gallatin Valley.
Crop .....	Clover.
Nature of soil.....	Clay loam.
Area .....	9.72 acres.
Date of first irrigation.....	June 3-6.
Date of second irrigation.....	July 13-17.
Average head of water used....	1.79 cu. ft. per sec.
Depth of water applied .....	1.65 ft.
Rainfall .....	.78 ft.
Total depth of water received..	2.43 ft.

**Experiment No. 41.**

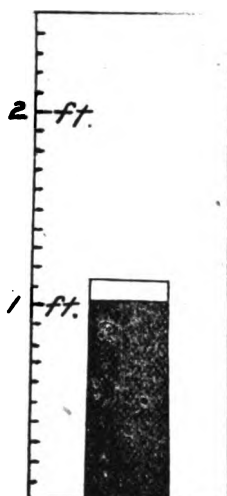
Location .....	Gallatin Valley.
Crop .....	Oats.
Nature of soil.....	Clay loam.
Area .....	8.83 acres.
Date of first irrigation.....	June 11-14.
Date of second irrigation.....	July 19-22.
Average head of water used....	1.49 cu. ft. per sec.
Depth of water applied .....	1.76 ft.
Rainfall .....	.54 ft.
Total depth of water received..	2.30 ft.

**Experiment No. 42.**

Location .....	Gallatin Valley.
Crop .....	Alfalfa.
Nature of soil .....	Clay loam.
Area .....	4.02 acres.
Date of first irrigation .....	June 10-11.
Date of second irrigation .....	July 17-18.
Average head of water used ....	1.56 cu. ft. per sec.
Depth of water applied .....	1.01 ft.
Rainfall .....	.78 ft.
Total depth of water received ..	1.79 ft.

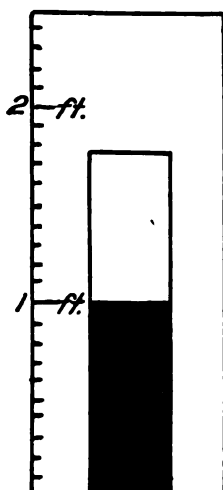
**Experiment No. 43.**

Location .....	Gallatin Valley.
Crop .....	Barley.
Nature of soil .....	Clay loam.
Area .....	19.8 acres.
Date of first irrigation .....	June 14-17.
Date of second irrigation .....	July 25-30.
Average head of water used ....	2.17 cu. ft. per sec.
Depth of water applied .....	.97 ft.
Rainfall .....	.64 ft.
Total depth of water received ..	1.61 ft.

**Experiment No. 44.**

Location .....	Gallatin Valley.
Crop .....	Rotation Plats.
Nature of soil .....	Clay loam.
Area .....	6 acres.
Date of first irrigation .....	June 26-27.
Date of second irrigation .....	July 18-19.
Average head of water used .....	1.92 cu. ft. per sec.
Depth of water applied .....	1.07 ft.
Rainfall .....	.64 ft.
Total depth of water received..	1.71 ft.

NOTE: Rainfall as given in cut is incorrect and should be .64 ft.

**Experiment No. 45.**

Location .....	Gallatin Valley.
Crop .....	Clover.
Nature of soil .....	Loam.
Area .....	27.84 acres.
Date of first irrigation .....	June 17-24.
Depth of water applied .....	1.00 ft.
Rainfall .....	.78 ft.
Total depth of water received..	1.78 ft.

**Experiment No. 46.**

Location.....	Gallatin Valley.
Crop .....	Clover.
Nature of soil .....	Loam.
Area .....	81.3 acres
Date of first irrigation.....	June 6-30
Average head of water used....	0.83 cu. ft. per sec.
Depth of water applied.....	3.13 ft.
Rainfall.....	.78 ft.
Total depth of water received..	3.91 ft.

Table No. 1.

In the following table, the length of the irrigation season for each of the valleys in which experiments were made has been fixed. Knowing approximately the number of days in which water is used, it is possible to determine the duty of water in acres per cubic foot per second and also per miner's inch. This has been done in columns 8 and 9 of table.

1899.

KIND OF CROP.	COUNTY.	AREA IRRIGATED IN ACRES.	YIELD PER ACRE	LENGTH OF IRRIGATION SEASON.	RAINFALL IN DEPTH OVER SURFACE.	AMOUNT OF WATER APPLIED.		
						IN DEPTH OVER SURFACE.	IN ACRES PER CU. FT. PER SEC.	IN ACRES PER MINER'S INCH.
Clover.....	Gallatin.	27.44	8 tons.	June 1-Aug. 31	FEET.	1.02	179	4.4
Peas.....	"	4.23	31.25 bu.	92 Days	.44	.44	166	4.1
Grain.....	"	11.27	51.46 "	"	.41	1.10	92	2.3
Barley.....	"	66.39	"	"	.41	.96	166	4.6
Oats.....	"	23.41	51.00 bu.	"	.38	1.53	119	3.0
Oats.....	"	1.26	12.75 bu.	"	.36	1.34	136	3.4
Oats.....	"	2.43	"	"	.36	2.16	84	2.1
Oats.....	"	25.00	"	"	.44	1.23	143	3.5

1900.

KIND OF CROP.	COUNTY.	AREA IRRIGATED IN ACRES.	YIELD PER ACRE	LENGTH OF IRRIGATION SEASON.	RAINFALL IN DEPTH OVER SURFACE.	AMOUNT OF WATER APPLIED.		
						IN DEPTH OVER SURFACE.	IN ACRES PER CU. FT. PER SEC.	IN ACRES PER MINER'S INCH.
Clover.....	Gallatin.	66.39	46.50 bu.	June 1-Aug. 31.	FEET	1.98	92	2.3
Barley.....	"	4.14	"	92 days	.28	1.50	122	3.1
Oats.....	"	25.06	"	"	.39	.64	235	7.1
Wheat 1 a.	"	"	w-38.33 bu	"	.30	.77	237	5.6
Clover 1 a.	"	2.00	c-31.70 lb.	"	"	.56	326	8.2
Oats 1 a.	"	2.00	o-75.58 bu.	"	.28	1.17	156	3.0
Barley.....	"	1.00	p-1350 lb.	"	.40	1.39	131	3.3
Oats.....	"	8.51	74.67 "	"	.42	1.96	98	2.8
Barley.....	"	4.32	63.59 "	"	.44	2.70	67	1.7
Clover.....	"	7.26	5.00 tons.	May 18-Sept. 30	.44	1.79	102	2.5
Clover.....	"	26.90	"	185 days	.44	1.80	206	5.1
Alfalfa.....	Yellowstone.	40.00	5.17 tons.	Apr. 25-Aug. 31	.13	1.46	174	4.3
Orchard.....	Bavali.	161.70	33.00 bu.	128 days	.13	1.30	165	4.9
Oats.....	"	108.50	34.60 bu.	"	.13	6.00	42	1.0

1901

KIND OF CROP.	COUNTY.	AREA IRRIGATED IN ACRES.	YIELD PER ACRE.	LENGTH OF IRRIGATION SEASON.	RAINFALL IN DEPTH OVER SURFACE.	AMOUNT OF WATER APPLIED.		
						IN DEPTH OVER SURFACE.	IN ACRES PER CU. FT. PER SEC.	IN ACRES PER MINER'S INCH.
Clower.....	Gallatin.	20.86	3.36 tons	June 1-Aug. 31. 92 days.	FEET	1.92	186	4.9
Clower.....	"	5.59	3.36 "	"	.67	1.81	101	2.5
Clower.....	"	7.13	3.36 "	"	.82	1.24	147	3.7
Clower.....	"	0.85	3.36 "	"	.62	1.35	118	2.9
Wheat.....	"	5.25	46.20 bu.	"	.45	1.20	132	3.8
Wheat 1 a.	"	1.00	W-42.90 "	"	.34	0.77	237	5.9
Barley 1 a.	"	1.00	B-61.50 "	"	.43	0.77	237	5.9
Clower 1 a.	"	1.00	C-1.39 ton	"	.45	1.14	125	3.0
Sugar beet	"	15.33	10 tons	"	.45	1.63	112	2.3
Oats.....	"	27.84	73 bu.	"	.62	.85	192	4.8
Clower.....	"	12.47	3 tons	"	.46	.85	225	5.8
Barley.....	"	8.41	59.0 bu.	"	.45	1.27	121	3.0
Peas.....	"	37.80	37.5 bu.	"	.49	1.54	163	3.6
Oats.....	Revalli.	40.00	0.9 ton	Apr 25-Aug 31. 128 days.	.49	1.50	169	4.1
Orchard.....	"	101.70	1.0 ton	"	.49	1.50	169	4.2
Clower.....	"	102.00	1.0 ton	"	.45	2.22	114	2.8

1902

KIND OF CROP.	COUNTY.	AREA IRRIGATED IN ACRES.	YIELD PER ACRE.	LENGTH OF IRRIGATION SEASON.	RAINFALL IN DEPTH OVER SURFACE.	AMOUNT OF WATER APPLIED.		
						IN DEPTH OVER SURFACE.	IN ACRES PER CU. FT. PER SEC.	IN ACRES PER MINER'S INCH.
Barley.....	Gallatin.	19.80		June 1-Aug. 31 92 days	FEET	.97	189	4.7
Rotation	"	6.00		"	1.07		171	4.3
Wheat.....	"	5.61		"	2.44		75	1.9
Oats.....	"	3.33		"	1.27		144	3.6
Clower.....	"	9.72		"	.78		110	2.7
Oats.....	"	8.93		"	1.77		103	2.6
Alfalfa.....	"	4.02		"	1.01		181	4.5
Clower.....	"	27.84		"	.78		103	2.6
Clower.....	"	81.30		"	.78	5.13	58	1.5

### DUTY OF WATER UNDER CANALS.

As has already been stated, the amount of water used under canals is much greater than under laterals, or on individual farms or fields. This difference is readily accounted for when one takes into consideration the porous character of most channels, the defects in construction and the loss due to evaporation. In addition to this, there is another loss. Except during the busy part of the irrigation season, most canals carry a surplus which is allowed to flow through, or over, waste-gates and return to the natural stream. The stockholder of a canal company prefers to waste a part of his allowance rather than wait until an additional supply can be turned in at the headgate miles away from his farm. Hence it follows that during the first and last part of the irrigation season, or during a rainy spell, considerably more water is allowed to flow through the canal than is utilized. In determining the duty of water under canals it was not practicable to measure losses of this nature. Each canal was measured daily at some suitable point near the head and the flow expressed in acre-feet. It will be remembered that an acre-foot is the quantity of water which will cover an acre one foot deep. When the flow of a canal is given in acre-feet it can be readily changed into miners' inches by multiplying the former by 20. This method is not quite exact but will answer for all practical purposes. In one of the accompanying tables the flow of the Big Ditch in Yellowstone county on July 22, 1902, is given as 710 8-10 acre-feet. Multiplying 710 8-10 by 20 gives 14216 miners' inches. The exact number is 14,336 miners' inches.

### DUTY OF WATER UNDER THE BIG DITCH, YELLOWSTONE COUNTY.

The canal now known as The Big Ditch is one of the largest in the state. It was begun in 1882 by the Minnesota and Montana Land and Improvement Company and completed several years later at a total cost of \$110,000. The canal, as originally built, was to be 30 feet on the bottom over the upper portion, with side slopes of 1 to 1, a water depth of 3 feet and grade of  $2\frac{1}{2}$  feet per mile.

The headgates and diversion dam of this canal are located on a branch of Yellowstone river, below the Rapids and about 11 miles above Park City. The lower terminus is near the city of Billings, 39 miles distant. There are no diversions on the upper portion of the canal and the upper rating flume was in consequence located at Tilden's ranch, about five miles below the head. The daily discharge of the canal at this point has been determined for the past three seasons. The following table represents the total volumes passing this point expressed in acre-feet for the year named, the respective areas under irrigation, the depth of water applied and the duty of water in acres per miner's inch:

YEAR	ACRE-FEET.	ACRES.	DEPTH IN FEET.	ACRES PER MINER'S INCH.
1900	46,905			
1901	46,507	18,144	2.58	2.13
1902	73,165	20,038	3.65	1.90

The total volumes carried in 1900 and 1901 are about equal. The canal was enlarged before the beginning of the past season (1902) and as is shown by the foregoing table the volume was much increased. Part of this supply was wasted. Notwithstanding the quantities of water wasted the average duty of water over about 20,000 acres in Yellowstone county for the years 1901 and 1902 was at the rate of one-half a miner's inch per acre.

In order to familiarize the irrigators with the various units used in irrigation the daily discharge of The Big Ditch for 1901 and 1902 is given in the following tables in three ways, viz: in cubic feet per second, Montana miners' inches and in acre-feet:

TABLE SHOWING DISCHARGE OF THE BIG DITCH AT TILDEN'S RANCH, YELLOWSTONE COUNTY, MONTANA, FOR THE SEASON OF 1901.

	May.			June.			July.			August.		
	Cu. ft. per sec.	Miner's inches	Acre feet	Cu. ft. per sec.	Miner's inches	Acre feet	Cu. ft. per sec.	Miner's inches	Acre feet	Cu. ft. per sec.	Miner's inches	Acre feet
1				174	6960	345.1	267	10680	529.5	246	9840	487.9
2				174	6960	345.1	256	10240	507.7	246	9840	487.9
3				174	6960	345.1	225	9000	446.2	246	9840	487.9
4				174	6960	345.1	252	10080	499.8	246	9840	487.9
5				174	6960	345.1	277	11080	549.3	236	9440	468.1
6				174	6960	345.1	267	10680	529.5	236	9440	468.1
7				174	6960	345.1	277	11080	549.3	236	9440	468.1
8				174	6960	345.1	288	11520	571.2	225	9000	446.2
9				174	6960	345.1	288	11520	571.2	225	9000	446.2
10				174	6960	345.1	288	11520	571.2	225	9000	446.2
11				174	6960	345.1	299	11960	593.0	225	9000	446.2
12				174	6960	345.1	299	11960	593.0	215	8600	426.4
13				184	7360	364.9	299	11960	593.0	215	8600	426.4
14	174	6960	345.1	184	7360	364.9	299	11960	593.0	257	10280	509.7
15	174	6960	345.1	164	6560	325.3	288	11520	571.2	257	10280	509.7
16	174	6960	345.1	164	6560	325.3	267	10680	529.5	246	9840	487.9
17	174	6960	345.1	164	6560	325.3	267	10680	529.5	246	9840	487.9
18	174	6960	345.1	164	6560	325.3	257	10280	509.7	246	9840	487.9
19	174	6960	345.1	143	5720	283.6	252	10080	499.8	236	9440	468.1
20	174	6960	345.1	143	5720	283.6	242	9680	480.0	236	9440	468.1
21	174	6960	345.1	143	5720	283.6	232	9280	460.1	236	9440	468.1
22	174	6960	345.1	112	4480	222.1	236	9440	478.1	236	9440	468.1
23	174	6960	345.1	112	4480	222.1	242	9680	480.0	267	10680	529.5
24	174	6960	345.1	112	4480	222.1	246	9840	487.9	257	10280	509.7
25	174	6960	345.1	91	3640	180.5	246	9840	487.9	236	9440	468.1
26	174	6960	345.1	91	3640	180.5	246	9840	487.9	236	9440	468.1
27	174	6960	345.1	225	9000	446.3	257	10280	509.7	184	7360	364.9
28	174	6960	345.1	225	9000	446.3	267	10680	529.5	184	7360	364.9
29	174	6960	345.1	246	9840	487.9	267	10680	529.5	174	6960	345.1
30	174	6960	345.1	277	11080	549.4	255	10200	505.7	164	6560	325.3
31	174	6960	345.1	...	...	...	242	9680	480.0	164	6560	325.3
Totals.....			6211.8	9980.5			16243.9			14070.6		

Summary showing the amount of water applied to irrigated lands under The Big Ditch for the season of 1901:

Duration of irrigation season (May 14 to Aug. 31).....	110 days.
Area irrigated.....	18,144 acres.
Water diverted.....	46,507 acre feet.
Average depth of water applied.....	2.56 feet.

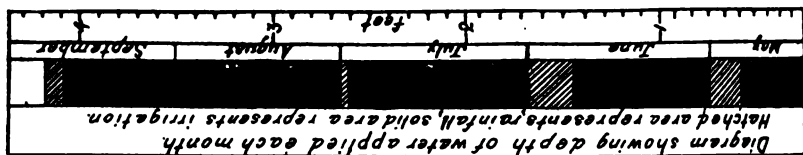
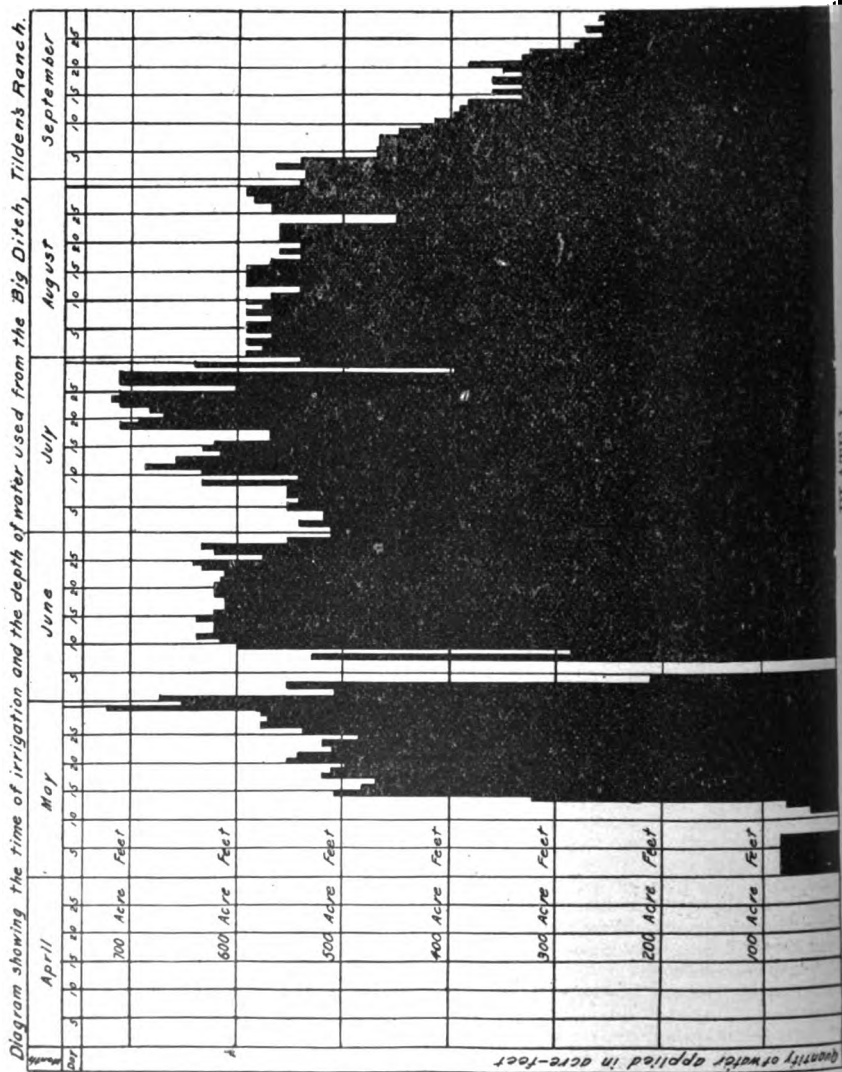


TABLE SHOWING DISCHARGE OF THE BIG DITCH AT TILDEN'S RANCH, YELLOW-STONE COUNTY, MONTANA, FOR THE SEASON OF 1902.

	May.			June.			July.			August.			September.		
	Cu. ft. per sec.	Minor's inches.	Acre feet.	Cu. ft. per sec.	Minor's inches.	Acre feet.	Cu. ft. per sec.	Minor's inches.	Acre feet.	Cu. ft. per sec.	Minor's inches.	Acre feet.	Cu. ft. per sec.	Minor's inches.	Acre feet.
1				338.1	13524	670.6	272.3	10892	540.1	293.9	11756	582.9	289.9	10796	535.3
2				254.4	10176	504.6	260.4	10416	516.5	290.3	11612	575.8	289.9	10796	535.3
3				278.3	11132	552.0	260.4	10416	516.5	293.9	11756	582.9	258.0	10320	511.7
4				104.9	4196	208.0	278.3	11132	552.0	286.7	11468	568.6	248.4	9938	492.7
5							284.3	11372	544.0	293.9	11756	582.9	236.4	9456	468.9
6							278.3	11132	552.0	293.9	11756	582.9	234.1	9364	464.3
7							278.3	11132	552.0	286.7	11468	568.6	234.1	9364	464.3
8				286.3	10652	528.2	266.3	10652	528.1	293.9	11756	582.9	228.9	9076	450.0
9				293.9	11756	582.9	284.3	11572	544.0	290.3	11652	575.8	222.1	8884	540.5
10				302.2	12088	599.4	320.2	12808	635.1	293.9	11756	582.9	214.9	8608	426.2
11				310.6	12424	616.0	346.5	13890	687.2	286.7	11468	568.6	210.1	8404	416.7
12				320.2	12808	635.1	332.1	13284	658.7	284.3	11322	544.0	200.6	8024	397.8
13				314.2	12568	623.2	310.6	12424	616.0	293.9	11756	582.9	197.6	7904	391.9
14	161.6	6464	320.5	314.2	12568	623.2	317.8	12712	630.3	293.9	11756	582.9	191.6	7664	380.0
15	254.4	10176	504.6	320.2	12808	635.1	314.2	12568	623.2	293.9	11756	582.9	187.7	7608	332.6
16	242.2	9696	480.8	314.2	12568	623.2	338.1	13524	670.6	293.9	11756	582.9	179.6	7184	356.2
17	236.0	9220	467.2	308.2	12328	611.3	338.1	13524	670.6	286.7	11468	568.6	167.7	6708	332.6
18	203.9	10556	523.4	308.2	12328	611.3	338.1	13524	670.6	272.3	10892	540.1	179.6	7184	336.2
19	255.6	10224	506.9	314.2	12568	623.2	350.1	14004	694.4	281.9	11276	559.1	167.7	6708	332.6
20	250.8	10032	497.4	314.2	12568	623.2	344.1	13764	682.3	281.9	11296	559.1	167.7	7084	350.2
21	278.3	11132	552.0	314.2	12568	623.2	344.1	13764	682.3	281.9	11296	559.1	167.7	7084	380.0
22	272.3	10892	540.1	310.6	12424	616.0	338.1	13524	670.6	272.3	10892	540.1	179.6	7084	380.0
23	255.6	10224	506.9	309.4	12376	613.6	362.0	14480	717.9	281.9	11296	559.1	164.7	6588	326.6
24	262.4	10496	520.4	317.8	12712	630.3	332.0	14336	710.8	226.9	9076	451.0	143.8	5752	285.2
25	244.8	9792	485.5	320.2	12808	635.1	358.4	14144	601.3	226.9	9076	451.0	140.8	5632	279.2
26	271.1	10844	537.7	320.3	11612	575.8	358.4	14336	710.8	286.7	11468	568.6	131.2	5248	280.2
27	280.3	11612	575.8	314.2	12568	623.2	358.4	14336	710.8	286.7	11468	568.6	137.8	5512	273.3
28	286.7	11468	568.6	317.8	12712	630.3	390.6	8024	397.8	293.9	11756	582.9	128.2	5128	254.2
29	280.3	11612	575.8	278.3	11132	552.0	326.1	13044	646.8	298.7	11948	592.4	131.2	5248	280.2
30	314.2	12568	623.2	256.8	10272	509.3	283.9	11756	582.9	298.7	11948	592.4	128.2	5128	254.2
31	328.5	13140	651.5				284.3	11372	544.0	274.7	10968	544.8			
Total	10197.7			15580.1			19134.5			17408.9			11442.9		

Summary showing the amount of water applied to irrigated lands under The Big Ditch for the season of 1902:

Duration of irrigation season (May 14 to Sept. 30)..... 140 days.  
 Area irrigated..... 20,038 acres.  
 Water diverted..... 73,165 acre-feet.  
 Average depth of water applied..... 3.65 feet.

### Duty of Water in the Bitter Root Valley.

For three years investigations have been conducted in the Bitter Root Valley to determine the quantity of water used in irrigation and the various losses in its conveyance. The greater part of the work was performed on the Bitter Root stock farm, the property of the late Hon. Marcus Daly. The conditions on this farm are favorable for such investigations. Through the co-operation of the Superintendent, Mr. P. J. Shannon, and the irrigation engineer, Mr. W. D. Kippen, accurate data have been secured in regard to the area of land irrigated and the kinds of crops raised. The results obtained in 1900 were published in Bulletin No. 29 of this station. Bulletin No. 119 of the office of Experiment Stations contains the results of the investigations made in 1901 while the following tables give a summary of the data obtained in 1902.

### DUTY OF WATER UNDER THE HEDGE CANAL, RAVALLI COUNTY, MONTANA.

The Hedge canal diverts water from the Bitter Root river a number of miles above the Republican canal. This canal is 24 miles long and irrigated during the past season 5,420 acres of first bench lands immediately above the areas covered by the Republican canal. The upper portion skirts the river and consists chiefly of flumes and inverted siphons. There are about five miles of flumes and 1,100 feet of redwood stave pipe. The greatest flow during the season of 1902 was 5,092 miners' inches, and occurred June 21 and 22.

Plate III shows by diagrams the quantity of water flowing past the upper measuring flume and also the depths of water applied to the irrigated land each month.

DAILY DISCHARGE OF THE HEDGE CANAL, AS MEASURED IMMEDIATELY BELOW THE WASTE-GATES, WHICH ARE LOCATED ABOUT 3,000 FEET BELOW THE HEAD-GATES, APRIL 14 TO SEPTEMBER 30, 1902.

Day	APRIL Acre-Feet.	MAY Acre-Feet.	JUNE Acre-Feet.	JULY Acre-Feet.	AUGUST Acre-Feet.	SEPT. Acre-Feet.
1	.....	151.7	146.3	242.1	211.2	189.8
2	.....	151.7	146.3	242.1	211.2	189.8
3	.....	146.3	124.9	242.1	211.2	189.8
4	.....	146.3	113.8	62.8	211.2	189.8
5	.....	151.7	124.9	211.2	211.2	189.8
6	.....	151.7	130.1	211.2	211.2	189.8
7	.....	135.7	135.4	211.2	211.2	189.8
8	.....	189.8	155.3	211.2	211.2	189.8
9	.....	189.8	189.8	178.5	211.2	189.8
10	.....	189.8	198.4	178.5	211.2	189.8
11	.....	189.8	198.4	178.5	211.2	178.5
12	.....	191.7	216.4	178.5	211.2	178.5
13	.....	216.4	226.7	178.5	211.2	178.5
14	46.2	211.2	237.0	198.4	211.2	189.8
15	62.8	155.3	242.1	198.4	211.2	189.8
16	62.8	211.2	242.1	198.4	211.2	189.8
17	62.8	189.8	231.8	198.4	211.2	189.8
18	81.9	189.8	242.1	178.5	211.2	189.8
19	81.9	189.8	242.1	178.5	194.7	189.8
20	81.9	189.8	242.1	178.5	194.7	178.5
21	92.2	178.5	252.5	146.3	194.7	178.5
22	103.3	178.5	252.5	146.3	189.8	178.5
23	103.3	178.5	242.1	178.5	189.8	189.8
24	103.3	178.5	242.1	178.5	183.0	189.8
25	135.1	178.5	242.1	211.2	189.8	189.8
26	147.8	167.8	242.1	198.4	189.8	189.8
27	140.8	167.8	247.3	198.4	189.8	189.8
28	140.8	167.8	247.3	198.4	189.8	189.8
29	140.8	167.8	247.3	216.4	189.8	189.8
30	140.8	167.8	242.1	216.4	189.8	189.8
31	.....	167.8	.....	211.2	189.8	.....

### DUTY OF WATER UNDER THE HEDGE CANAL.

	1901.	1902.
Area irrigated.....acres	5,260	5,420
Water used.....acre-feet	20,883	31,274
Average depth of water applied.....feet	3.97	5.76
Duty of water in acres per miner's inch.....acres	1.64	1.46

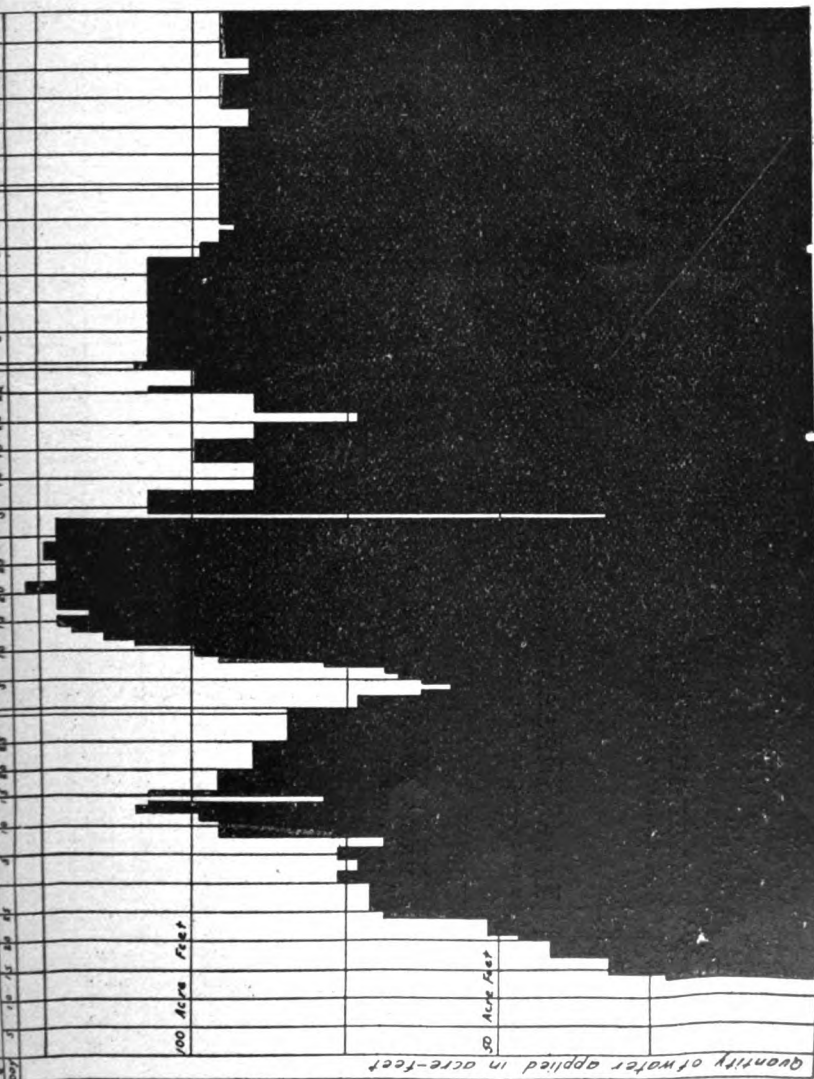
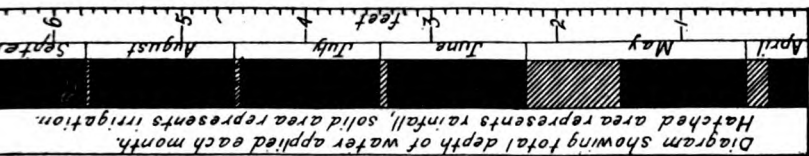


PLATE III

## DUTY OF WATER UNDER THE WARD CANAL.

The Ward canal diverts water from the Skalkaho creek, a tributary of the Bitter Root river. In 1902 this canal irrigated 3,985 acres of bench lands located above the Hedge canal. It is 7 miles long, has a bottom width of about 8 feet and is built on a grade of 5.28 feet per mile. The greatest flow during 1902 was 2,809 miners' inches and occurred June 23 to July 3.

Plate IV shows by means of a diagram the daily discharges for 1902 and the average depths of water applied each month of the irrigation season.

## DAILY DISCHARGE OF THE WARD CANAL, AS MEASURED AT THE OLD FLUME NEAR THE HEAD ON SKALKAHO CREEK, APRIL 18 TO SEPTEMBER 30, 1902.

Day	APRIL. Acre-Feet.	MAY. Acre-Feet.	JUNE. Acre-Feet.	JULY. Acre-Feet.	AUGUST. Acre Feet.	SEPT. Acre-Feet
1	.....	17.6	118.4	138.8	51.7	13.2
2	.....	17.6	118.4	138.8	51.7	13.2
3	.....	13.2	118.4	138.8	51.7	13.2
4	.....	13.2	97.7	35.9	35.9	13.2
5	.....	13.2	97.7	107.9	35.9	13.2
6	.....	13.2	107.9	107.9	35.9	13.2
7	.....	22.8	107.9	107.9	35.9	13.2
8	.....	22.8	118.4	107.9	35.9	13.2
9	.....	51.7	118.4	88.2	22.8	6.7
10	.....	69.4	118.4	88.2	22.8	6.7
11	.....	69.4	118.4	88.2	22.8	6.7
12	.....	88.2	118.4	97.7	22.8	6.7
13	.....	88.2	128.3	88.2	22.8	6.7
14	.....	88.2	128.3	81.6	22.8	6.7
15	.....	51.7	128.3	88.2	22.8	6.7
16	.....	107.9	128.3	88.2	22.8	6.7
17	.....	88.2	128.3	88.2	22.8	6.7
18	22.8	107.9	128.3	88.2	22.8	6.7
19	22.8	107.9	128.3	51.7	22.8	6.7
20	22.8	107.9	128.3	51.7	22.8	6.7
21	29.1	97.7	128.3	51.7	22.8	6.7
22	22.8	97.7	128.3	51.7	22.8	6.7
23	13.2	97.7	138.8	69.4	22.8	6.7
24	13.2	107.9	138.8	69.4	17.6	6.7
25	13.2	128.3	138.8	69.4	17.6	6.7
26	13.2	128.3	138.8	88.2	17.6	6.7
27	13.2	118.4	138.8	69.4	17.6	6.7
28	13.2	97.7	138.8	69.4	17.6	6.7
29	13.2	88.2	138.8	51.7	17.6	6.7
30	17.6	88.2	138.8	51.7	17.6	6.7
31	.....	107.9	.....	51.7	6.7	.....

## DUTY OF WATER UNDER WARD CANAL.

	1901.	1902.
Area Irrigated.....acres	3,587	3,985
Water used.....acre-feet	8,628	9,133
Average depth of water applied.....feet	2.41	2.46
Duty of water in acres per miner's inch.....acres	2.81	3.30



## DUTY OF WATER UNDER SKALKAHO CANAL.

This canal, which is also supplied from Skolkaho creek is about 7 miles long, of which  $2\frac{1}{2}$  miles consist of flumes 4 feet 8 inches wide inside, by 2 feet 8 inches high. The grade is 5.28 feet per mile throughout. The greatest flow for the season of 1902 was 2,796 miners' inches and occurred July 1 and 2.

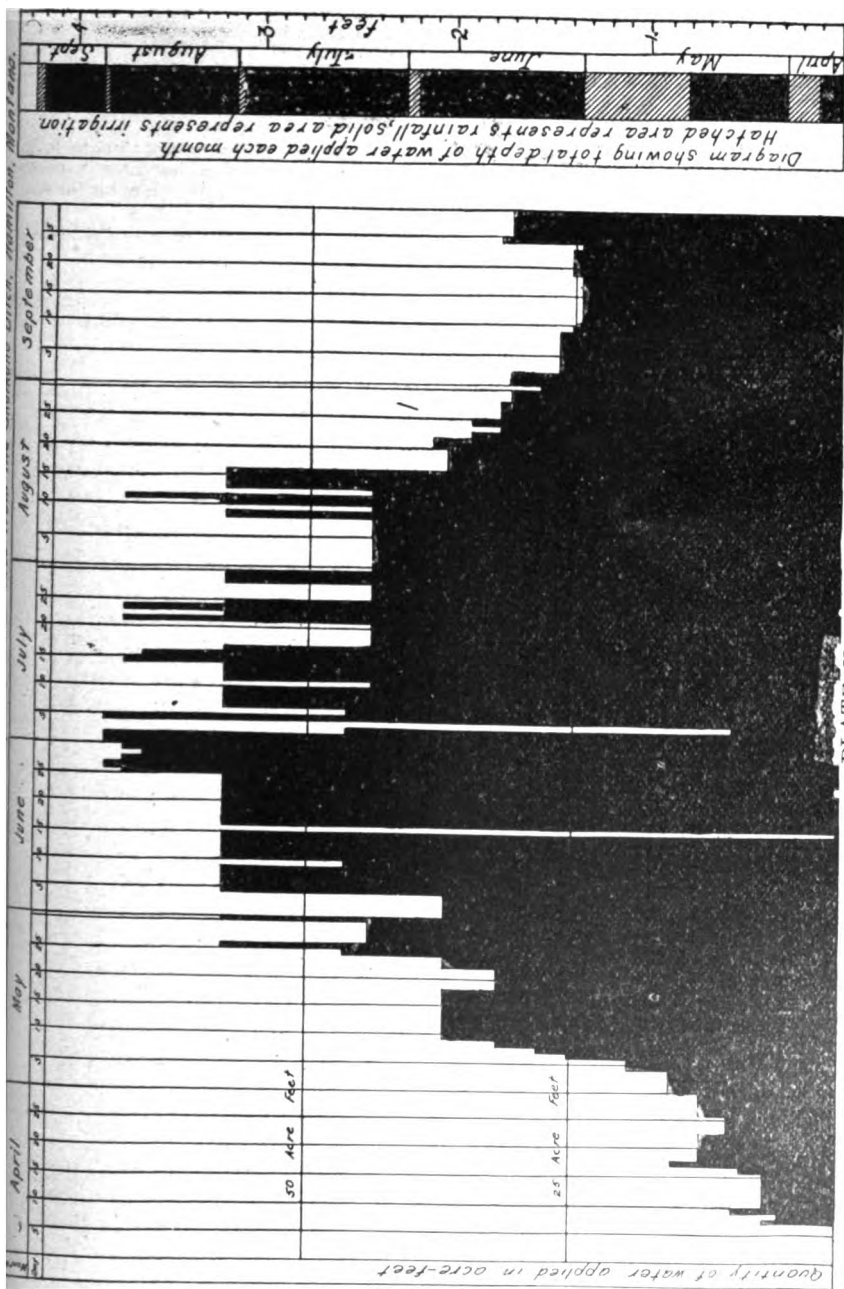
The diagram illustrating the flow on Plate V indicates considerable fluctuation in the flow.

DAILY DISCHARGE OF SKALKAHO CANAL, AS MEASURED JUST ABOVE THE UPPER SIPHON AND ABOUT TWO MILES BELOW THE HEAD, APRIL 8 TO SEPTEMBER 20, 1902.

DAY	APRIL. Acre-Feet.	MAY. Acre-Feet.	JUNE. Acre-Feet.	JULY. Acre-Feet.	AUGUST. Acre-Feet.	SEPT. Acre-Feet.
1	.....	30.1	73.3	138.6	82.3	61.2
2	.....	30.1	73.3	138.6	82.3	61.2
3	.....	30.1	73.3	91.2	82.3	54.3
4	.....	30.1	73.3	22.3	82.3	54.3
5	.....	39.1	120.0	133.6	82.3	54.3
6	.....	39.1	120.0	91.2	82.3	54.3
7	.....	50.9	120.0	120.0	82.3	54.3
8	13.2	57.7	120.0	120.0	82.3	54.3
9	10.1	64.6	120.0	120.0	120.0	54.3
10	19.2	73.3	91.2	120.0	82.3	50.9
11	13.2	73.3	120.0	82.3	120.0	48.0
12	13.2	73.3	120.0	120.0	134.4	48.0
13	13.2	73.2	120.0	120.0	82.3	48.0
14	13.2	73.3	120.0	120.0	120.0	48.0
15	13.2	73.3	120.0	134.4	120.0	48.0
16	13.2	73.3	.....	130.1	120.0	48.0
17	17.4	73.3	120.0	120.0	73.3	48.0
18	30.1	73.3	120.0	82.3	73.3	48.0
19	25.0	64.6	120.0	82.3	73.3	48.0
20	25.0	64.6	120.0	82.3	73.3	50.9
21	25.0	64.6	120.0	82.3	77.7	50.9
22	25.0	64.6	120.0	134.4	77.7	50.9
23	25.0	73.3	120.0	120.0	63.8	50.9
24	22.3	73.3	120.0	121.1	64.6	48.0
25	22.3	82.3	120.0	120.0	63.8	64.6
26	22.3	82.3	121.1	82.3	64.6	61.2
27	25.0	82.3	120.0	82.3	64.6	61.2
28	25.0	82.3	121.1	82.3	64.6	61.2
29	25.0	82.3	121.1	120.0	61.2	61.2
30	25.0	82.3	121.1	120.0	61.2	61.2
31	.....	100.0	.....	82.3	57.7	.....

## DUTY OF WATER UNDER SKALKAHO CANAL.

	1901.	1902.
Area Irrigated..... acres	1,600	1,975
Water used..... acre-feet	7,494	13,423
Average depth of water applied..... feet	4.68	6.79
Duty of water in acres per miner's inch..... acres	1.40	1.21



## DUTY OF WATER UNDER GIRD CREEK CANAL

The entire flow of Gird Creek is utilized for irrigation purposes during the summer months by means of two canals. Of the South Gird canal is the higher and irrigates lands beyond the end of the Skalkaho canal. South Gird canal, or ditch, is six feet wide on the bottom, two feet deep and is built on a grade of 5.28 feet per mile. North Gird canal is of about the same dimensions and irrigates the lands lying north of Gird Creek and above the Ward canal. During the past season the maximum flow of the North canal was 1,128 miners' inches and of the South canal 1,660 miners' inches.

The following table with the accompanying diagram represents the discharge of South canal for 1902, while the remaining table gives the duty of water under the North canal.

DAY.	APRIL. Acre-Feet.	MAY. Acre-Feet.	JUNE. Acre-Feet.	JULY. Acre-Feet.	AUG. Acre-Feet.	SEPT. Acre-Feet.
1		21.62	65.26	73.79	56.43	56.43
2	....	21.62	73.79	73.79	65.26	56.43
3	....	21.62	73.79	73.79	65.26	56.43
4	....	21.62	78.15	....	56.43	56.43
5	....	21.62	82.32	78.15	65.26	56.43
6	....	30.35	78.15	82.32	73.79	43
7	....	30.35	78.15	78.15	73.79	30.35
8	....	30.35	82.32	73.79	82.32	30.35
9	7.79	30.35	78.15	65.26	82.32	30.35
10	8.62	30.35	73.79	30.35	73.79	30.35
11	7.79	65.26	73.79	30.35	73.79	30.35
12	7.79	65.26	73.79	39.17	73.79	30.35
13	7.76	65.26	73.79	47.78	82.32	15.51
14	4.49	65.26	82.32	47.78	73.79	15.51
15	4.43	65.26	82.32	47.78	73.79	30.35
16	4.46	65.26	82.32	39.17	73.79	30.35
17	6.84	76.27	73.79	39.17	65.26	30.35
18	11.70	76.27	73.79	39.17	65.26	30.35
19	12.06	65.26	73.79	39.17	65.26	30.35
20	15.51	65.26	73.79	39.17	65.26	30.35
21	15.51	65.26	73.79	39.17	65.26	30.35
22	21.62	73.79	73.79	47.78	65.26	30.35
23	21.62	73.79	73.79	47.78	65.26	30.35
24	15.51	73.79	82.32	39.17	65.26	30.35
25	15.51	73.79	82.32	39.17	56.43	39.17
26	15.51	65.26	73.79	47.78	56.43	39.17
27	21.62	65.26	82.32	47.78	56.43	39.17
28	21.62	73.79	82.32	47.78	56.43	39.17
29	21.62	82.32	82.32	5.16	56.43	21.62
30	21.62	73.79	78.15	5.16	56.43	21.62
31		73.79		3.97	47.78	

## DUTY OF WATER UNDER THE NORTH GIRD CREEK CANAL.

Area irrigated.....	acres	1901.	1902.
Water used.....	acre-feet	1,211	1,345
Average depth of water applied.....	feet	1.45	3.50
Duty of water in acres per miner's inch.....	acres	2.56	2.04

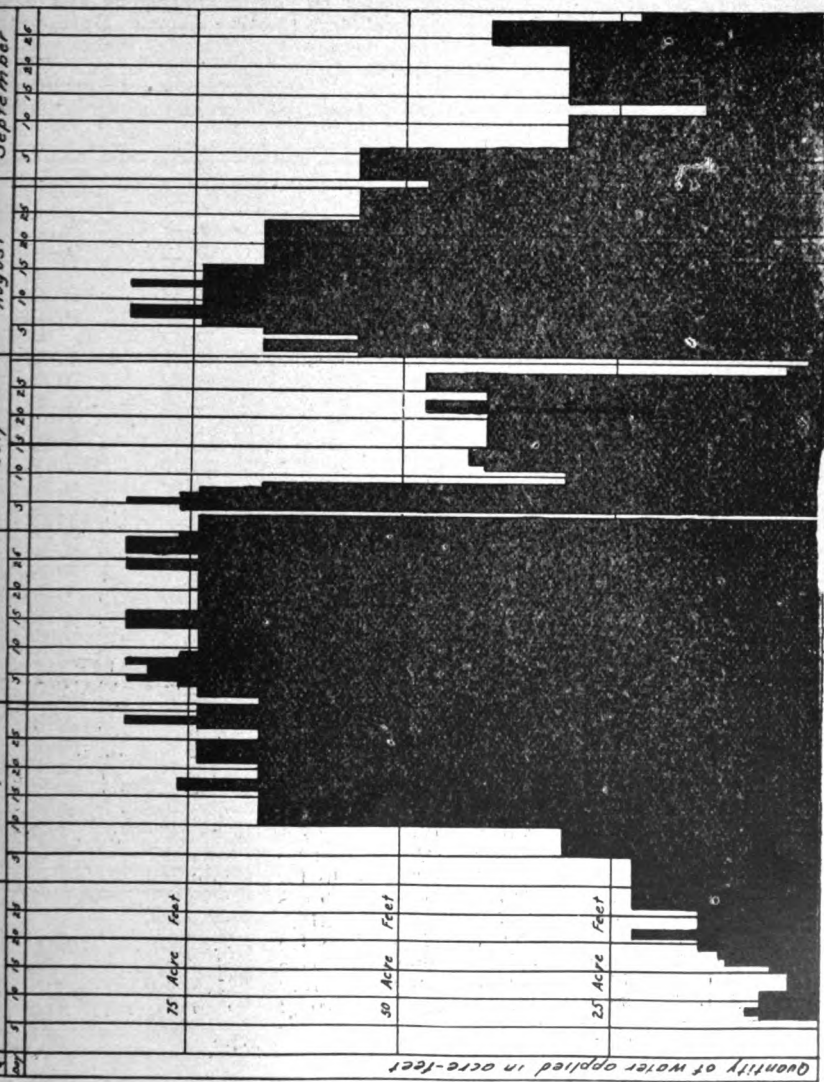
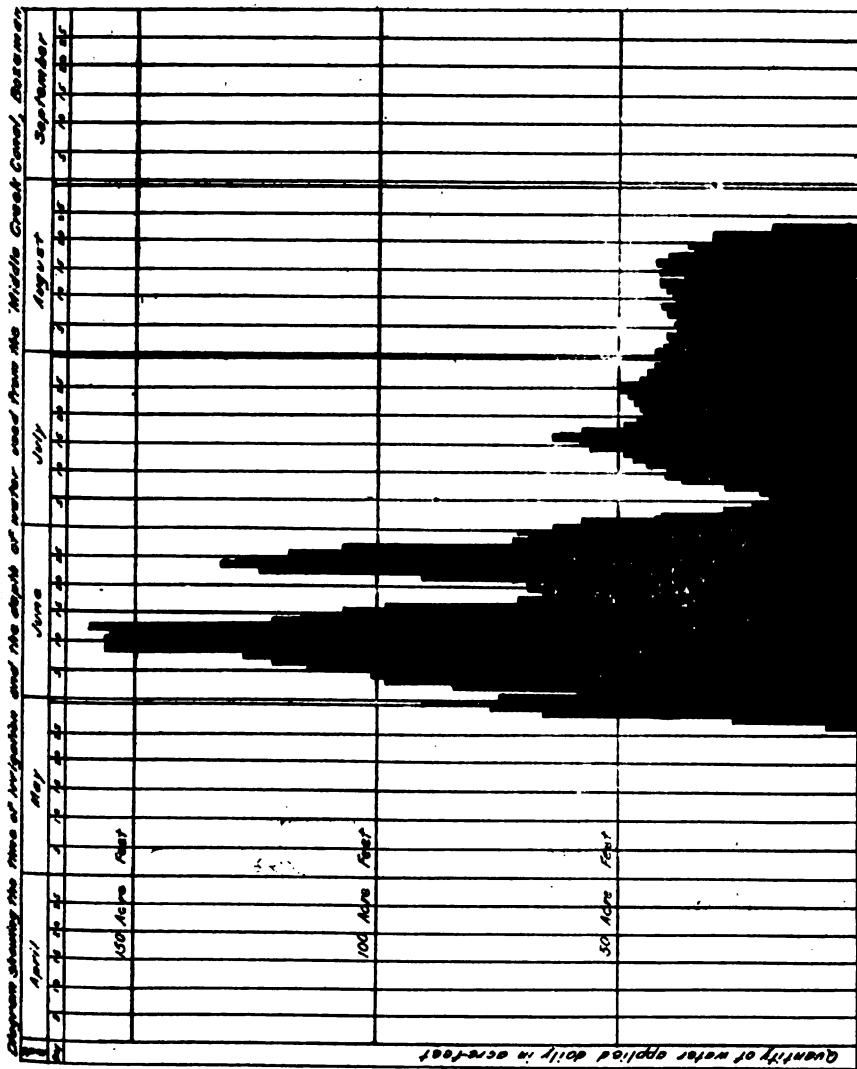


PLATE VI

DAILY DISCHARGE OF MIDDLE CREEK CANAL, AS MEASURED NEAR THE HEAD-GATES, FOR THE SEASON OF 1902.

PLATE VII.



farms south-west of Bozeman, including that of the Experiment Station. In the spring of 1899 a rating station was established just below the main headgates and the daily discharge has been determined for four successive seasons. In 1899 the area irrigated was obtained by interviewing each stockholder, whose statement was taken as the acreage on his farm watered from this source. The same acreage was used in 1900 but in 1901 a new census was taken which showed that the extent of land irrigated had decreased. During the past season Assistant Professor Baker, with the aid of several advanced students in civil engineering, made a complete plane table survey of Middle Creek and the district irrigated by means of ditches from this source. The acreage under this canal as contained in the following table may therefore be relied on. In 1899, 1135 acres were summerfallowed under this canal while in 1902 there were only 344 acres. A highly profitable clover crop being in nearly every case substituted for the unprofitable fallow-land

## DUTY OF WATER UNDER MIDDLE CREEK CANAL.

	1899.	1900.	1901.	1902.
Area irrigated.....acres	3,853	3,853	3,186	4,828
Water used.....acre-feet	8,074	7,324	7,454	5,577
Average depth of water applied.....feet	2.10	1.90	2.34	1.15
Duty of water in acres per miner's inch.....acres	2.19	2.75	2.26	3.78

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*Sci 1635.35.7*  
**BULLETIN NO. 44**

**MONTANA AGRICULTURAL**

# **Experiment Station**

**OF THE**

**AGRICULTURAL COLLEGE OF MONTANA**

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## **APPLE GROWING IN MONTANA**

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**BOZEMAN, MONTANA, FEBRUARY, 1903**

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**1902**

**The Avant Courier Publishing Co.  
Bozeman, Montana**

# Montana Agricultural Experiment Station, Bozeman, Montana.

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# Montana Experiment Station.

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Bulletin No. 44      -      -      -      -      February, 1903

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## APPLE GROWING IN MONTANA.

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R. W. FISHER.

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### Introduction.

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The people outside the natural fruit districts are fast realizing the fact that apples can be successfully grown in the higher altitudes of this state, and in many places where was once a barren waste, or cattle range, are now to be found young orchards, which are surely destined to produce fruit, and become a source of revenue to the farm.

The failures of the past in growing apple trees have been due to one or several of the following reasons:

1. Tender or worthless varieties.
2. Uncongenial soils.
3. Poor planting.
4. Insufficient or indifferent care after planting, or many causes that result in failure, in even more favored localities than ours.

However these attempts, although a failure was the immediate result, have been of very great value to the interests of horticulture, in that they have shown the varieties that can be successfully grown, and the methods best to pursue in the growing of these varieties.

With the exception of the Bitter Root valley, and possibly the Flathead and Yellowstone valleys, the question is, and has been,

ing more numerous, and because of the present tendency of stockmen to purchase and fence the ranges for their exclusive use, so that, while formerly there was no disposition to do more than avoid the "poison localities," the increased value of these ranges and private ownership now demand methods for the destruction of these injurious plants, so as to prevent unnecessary losses.

A glance at the literature of the subject will show that considerable work has already been done by the various Experiment Stations of the Northwest and more recently the work has been taken up by the Division of Botany of the Department of Agriculture, under the direction of Mr. V. K. Chesnut and several important papers have been published. The history of the work at this Station begins in 1895 when Dr. F. W. Traphagen took up the subject from the chemical standpoint, being joined the following year by Dr. E. V. Wilcox, the Zoologist and Veterinarian of the Station, co-operating with Dr. Bird, then State Veterinarian. The work was continued by Dr. Wilcox till 1899, when he went to Washington and the investigations have since been mainly under direction of the Botanist. The results of these studies have been presented in bulletins 15 and 22 by Dr. Wilcox and in the present issue.

From the investigation of a large number of cases of stock poisoning it appears that some 95 per cent of such losses in this state is due to five or six species of plants, or more strictly, groups of related species; namely, the loco, lupine, water hemlock, death camas, larkspur and wild parsnip, and that while cases of poisoning by other plants may, and doubtless do occur, these cases are relatively few and need not here be considered. The not infrequently fatal effects of alkali on the eastern ranges have been largely attributed to plant poisons and have served to swell the total and complicate the symptoms.

The object of this bulletin is to present a brief summary of our present knowledge of these poisonous plants—conclusions reached by the field-work of three seasons and from a study of the various bulletins and papers already published on the subject, in order that these plants may be recognized and the conditions under which the poisoning occurs be known, as well as the symptoms of such poisoning and the usual remedies. It must be remembered that as yet the exact symptoms of the different poisons in many cases have not been clearly determined, nor have efficient remedies been found, the subject being yet in the experimental stage, while for the successful solution of the various problems involved, the co-operation in experimental work of a veterinarian and a botanist with the aid of a chemist or pharmacist is necessary to secure the best results by the experimental feeding of these suspected plants in their various stages directly to the animals themselves, noting the quantity fed, the resulting symptoms and effects, as shown by examination after death, while later the work of seeking antidotes for these various poisons can

be undertaken. Work of this nature is expensive and can be performed only in localities where these plants grow, while as yet the desired co-operation of men and means has not been secured.

An attempt has been made to bring together at the end a brief synopsis of the symptoms of these poisons and the usual conditions when losses occur, in order that the stockman may be able to determine the cause of any case of poisoning that may arise.

There is also added a bibliography of the literature of the plants poisonous to stock in America, exclusive of the Fungi, as far as our library facilities here permit, and this may be of service to other investigators and stockmen who care to pursue the subject further. For the more exhaustive treatment of several phases of the subject, the stockmen of Montana are referred to the bulletin of Chesnut and Wilcox on the "Stock-Poisoning Plants of Montana" issued by the U. S. Department of Agriculture, to which we are indebted for figures 2, 3 and 6. Fig. 1 is from Vasey in the Report of the U. S. Commissioner of Agriculture for 1884, while the remaining figures are by students in this institution, figures 3 and 4 by Jacob Vogel and 5 by Amy M. Cooke.

Valuable assistance has also been rendered by Dr. M. E. Knowles, State Veterinarian, in the prosecution of this investigation, and I wish also to thank the many stockmen in the various parts of the state, who have aided me in this work, while without the efficient co-operation of the railways of the state, such work could hardly have been attempted.

## CONDITIONS OF POISONING.

The investigations here undertaken seem to show that stock-poisoning by plants is more frequent in certain sections of the state, in certain seasons of the year and during certain weather conditions and a knowledge of these zones, seasons and conditions may aid in materially reducing the losses from this cause.

The chief poison zones of the state are nearly confined to the foothills of the various mountain ranges east of the Continental Divide and to the high bench lands of the plains eastward. There has been little complaint from the extreme eastern or western parts of the state. These poison zones are characterized by the abundance of the larkspurs, lupines, death camas and wild parsnip, which are far less frequent or entirely absent further east or west. The loco zone is a well defined section near the central part of the state, while the water hemlock is frequent along streams from the foothills westward, being rare or entirely absent in the eastern plains. It is not the presence, but the abundance of these various plants, that determines these poison zones. The death camas is found in nearly every part of the state, but is abundant only in certain localities; the loco weed

occurs throughout the plains region of the United States and Canada, but is abundant only in certain parts of this region, where the poisoning mainly occurs.

The chief period of danger is in early spring from April 15 to June 15, more commonly from May 1 to May 15. It is during this period that the death camas, the larkspur the water hemlock and the wild parsnip are most apt to be eaten, as their herbage is then young and tender and there is much evidence to indicate that they are far more poisonous before they come into bloom; the first two fruit and die early in July while the others become coarse and unpalatable. This is also during the rainy season, when the ground is soft, and the more poisonous roots of these various plants may occasionally be pulled up, particularly by cattle. Periods of continuous rain cause stock to seek shelter, from which they come forth hungry and use less selection in their choice of forage, while they are apt to overeat the wet, rank vegetation and in consequence suffer from bloat and occasional poison. Late snows also cover the more edible grasses and force stock to eat the taller and often poisonous plants, like the large larkspur, the lupine and the water hemlock. Poisoning from loco is also more common during this same period when its conspicuous flowers point it out to lambs and the "loco eaters" and its green, fresh condition makes it more palatable. The lupine on the contrary, is most deadly in July and August, as it matures its seeds and its green herbage renders it conspicuous among the dry vegetation, while it is at this period that sheep are apt to be moved to the mountain and foothill pastures where the lupines are abundant. There are also not infrequent cases of poisoning in the winter by lupine hay or "slough hay" containing much water hemlock, occasionally even by the dry stalks and seeds of the lupine found on the ranges.

It must also be remembered that stock on their usual pastures and under normal conditions are not apt to be poisoned by these plants, even if abundant, but after times of rain or snow they should be looked after and stock of any kind driven to a new range or when hot and hungry, are apt to eat to excess unpalatable and poisonous plants. Hence in changing ranges or in trailing stock from one locality to another, it is necessary that more care than usual be exercised to prevent them from eating these poisonous plants until they become accustomed to their new conditions.

## LOCO.

*Oxytropis Lamberti* Pursh, or *Aragallus spicatus* (Hook.) Rydb.

The White Loco Weed is a small pea-like plant, six inches to a foot high, with conspicuous white or cream-colored flowers from a thick woody persistent root, and is fairly well represented in Fig. 1. The "White Loco" is distributed over nearly the whole plains region of the United States from Alberta and Assiniboia south into Mexico, and from Minnesota and Kansas westward to the Rockies. Extensive losses of stock attributed to this species are reported in New Mexico, Colorado and Montana and to a less extent in most of the other states embraced in the region mentioned. In southern California and some other states the loco is attributed to other plants and in particular to two species of *Astragalus* (*A. mollissimus* Torr. and *A. Hornii* Gray) neither of which are native here. In Montana the white loco is found throughout all the eastern plains and is not infrequent in the "mountain meadows" up to 8000 feet altitude. It has not been found west of the Continental Divide, although it occurs on this Divide in the vicinity of Feeley some ten miles south of Butte. To this species (*O. Lamberti*) must be attributed all or nearly all the cases of loco in this state, as the poisoning occurs only in sections where it is abundant and the other species suspected are too few or too scattered to do much damage. The white loco weed is very unevenly distributed over the section named and appears not to be found in sufficient abundance to be dangerous except in the central "loco zone" extending from Livingston to Billings and from the mountains on the south, northward to the Musselshell, and around the Little Belt and Highwood Mountains. Reports of loco have come from a few other localities in the state, but nowhere else have losses from this cause been heavy and constant. Indeed, in some parts of this "loco zone" the losses sometimes average as high as 50 per cent of the lambs produced and in several localities the sheepmen have been compelled to dispose of their sheep and stock with cattle. Yet it must not be supposed that the loco is equally and abundantly distributed over all this section. It is found mainly along dry rocky ridges or gravel plains, but exhibits great capacity for growing in nearly every kind of soil. Over much of this area the traveler will look in vain for a single specimen, while in other localities of similar soil, perhaps immediately adjacent, the plains will be white with its conspicuous flowers. This irregularity of distribution may be due in part to the difference in soil, but must be mainly attributed to the fact that it is a relatively recent introduction into the state and that it is spreading from the infected centers. There is considerable evidence to show that the buffalo were the original agents of its introduction, either through having eaten the mature seeds and then scattered them in their offal or from their habit of wal-



Fig. 1. LOCO WEED.  
Natural Size.

*Oxytropis Lambertii* P.  
(U. S. Dept. Agriculture.)

owing in the dust and thus carrying the seeds in their hair for considerable distances through their well known migratory habits. The usual presence of the loco weed in the vicinity of the "buffalo wallows" and its not infrequently abundant distribution in the higher mountain meadows along with abundant signs of the buffalo and in situations, such as the Tobacco Root Range, where sheep or other stock are not transferred from a loco section, tend to support this theory.

The evidence also seems to show that the loco is slowly spreading from the "loco zone" northward and eastward and that the sheep are now the main instruments of its dispersion and more abundant growth, both by spreading the seeds in their offal and in particular through their tramping in those seeds where already distributed when the ground is soft in the spring. It will also be observed that this "loco zone" is just that part of the state which has longest been given over to the pasturage of sheep.

It has been the general experience of the stockmen in this state that sheep are the chief sufferers from this poison, horses frequently and cattle are rarely affected. It is also a matter of common observation that it is the young sheep and colts that are affected, more frequently yearlings, while the older sheep and horses, grazing along with the others are rarely known to acquire the loco habit. It is also asserted by the stockmen that the animals teach the habit to each other and there is nothing improbable in the statement when we consider their imitative nature, particularly in the matter of grazing.

The loco is a slow poison and appears to affect primarily the nervous system, so that animals addicted to the habit become stupid, wander from the herd, step high, their eyes are glassy, their front teeth grow long and become loose, their coat becomes shaggy and they seek the loco weed and will eat nothing else if it can be obtained. They not only eat the plant itself, but dig for the roots with their hoofs. They appear to have false ideas of form, size and distance and horses in particular when they get hot or exhausted are apt to become frantic, whence the term "loco" or crazy has been applied to the disease. Moreover, the effects are usually lasting and no remedy has yet been found. Horses are permanently injured, as their "crazy" spells disqualifies them for hard work and but few cases of recovery from the effects of the poison have been noted. Sheep left on the ranges where the loco is found become worse and worse, their teeth become black and loose, they eat nothing but loco and they finally die from sheer inability to obtain sufficient food and water to sustain life. Once the habit is fixed, if left on the range they never recover, although they may linger along for several years before death, so that many of the stockmen kill all the animals affected on the approach of winter, rather than to attempt to care for such hopeless cases.

### HOW TO PREVENT STOCK FROM BECOMING LOCOED.

A careful study of the subject seems to show that it is the lambs and yearlings that are chiefly affected---old sheep but rarely and then on ranges where the loco is abundant and other forage scant. Also, it is usually colts that acquire the loco habit and the adult horses are much less apt to become addicted to it. This is due to the fact that the loco plant is in full bloom during May and June when the lambs and colts are just learning to graze and the conspicuous white flowers and their sweetish taste serve to attract them, while the intoxicating effects of the poison are more easily fixed in their system. They soon learn to recognize the plant and to seek it for the effects produced, until the desire for the intoxicating poison becomes a fixed habit, in much the same way that the opium or alcohol habit is fixed in man, and the effects are only more rapid because animals know no restraint and the supply of the drug is often unlimited. The loco poison is a true narcotic in its effects and appears to afford certain pleasurable sensations to the animals eating it, so that the desire for the drug finally becomes a passion, and once the taste for the plant is acquired, they will continue to seek it for the effects produced until they are removed from the loco ranges or die from its use.

Several instances have occurred in this "loco zone" where sheepmen have become discouraged on account of the losses from loco, and have sold out their ranches to others, who stocked them again with sheep and suffered little or no loss from loco. In some cases this immunity seems to have been due to the fact that only old sheep were grazed on these loco ranges, in others liberal salting was claimed to have prevented them from acquiring the abnormal taste for the loco weed, but such cases of apparent immunity are exceptional and need more careful study to determine the efficient cause in each instance.

If this theory, that the loco habit is contracted mainly when stock are learning to graze, be correct, then the disease may easily be prevented by grazing lamb-bands on ranges free from loco, at least till after the first of July, when they will have learned their proper forage and the loco will be out of bloom except in the mountain pastures, where no cases of loco poisoning have been reported, and the same is true of the young colts. It is probable that the yearlings affected have acquired the habit during the preceding spring, but in less degree and that it developed mainly during the second season. It will hence be necessary to look after the lambs and colts during the first two of three months after birth, and future care will not be needed.

Sheep taken in the early stages of the disease and placed on good pasturage free from loco, or on alfalfa, frequently take on flesh and are shipped East to be finished for the market, as the quality of the flesh itself is in no wise injured by the loco diet, but animals in ad-

vanced stages of the disease will never recover and may as well be killed for their pelts, as it appears to be the general experience of sheepmen that locoed sheep never produce offspring.

### CAN LOCO BE EXTERMINATED?

This question has often been asked and the subject is coming to be of importance, from the fact that many of the stockmen, particularly in the loco zone, are purchasing large holdings and fencing them for their exclusive use, while a number of them have been induced to sell because of the losses from the loco, or have sold their sheep and restocked with cattle, when such changes were entirely unnecessary.

Burning the ranges can do no good, except possibly to destroy some of the seed, as the plant has a deep enduring root from which new plants will arise next spring. Close pasturage in some cases appears to have destroyed the loco in small pastures and on some of the more closely grazed ranges, but there is always some risk that the animals will thus acquire the habit.

At least one state has made a serious attempt to aid the stockman to exterminate the loco. The legislature of Colorado passed a law in 1881 offering a bounty of \$21.00 a ton, dry, for "any loco or poison weed dug up not less than three inches below the surface of the ground during the months of May, June and July." This law was repealed in 1885, but cost the state about \$40,000 a year during the time it was in force, without any benefits at all commensurate to the expense, as there was no specification as to just what species were included under "loco or poison-weed" and no system employed in eradicating the objectionable plants. Yet, this law seems to have fairly well demonstrated, and indeed was based upon the fact, that loco can be exterminated by digging during the months specified. This seems to be the nearly unanimous opinion of a large number of Colorado stockmen, who have been consulted by this Station.

Now, while it is probably inadvisable for the state to attempt the extermination of loco on the public ranges, it is yet possible and profitable for the stockmen to eradicate it from his own private enclosures and this at relatively small expense, as a recent experiment in Sweet Grass county has demonstrated.

A practical test of the matter in this state was made by Dr. W. A. Tudor of Bozeman on his ranch on the Big Coulee, thirty miles northeast of Big Timber. During the season of 1901 Dr. Tudor lost from poisoning by loco about 300 out of a herd of 2000 lambs. Acting on advice from this station, the next spring (1902) he employed two men for about a month in May and June to dig up the loco plants over an area of about four miles square. The plants were cut off just below the crown—the point where the leaves arise from the root, two or three inches below the surface, a narrow

heavy hoe being used, and wherever this was properly done plants never sprouted again, nor have new plants come up in the next season (1903). No further losses from loco have occurred on the ranch.

From this it appears that the extermination of the loco (*Oxytropis Lamberti*) is perfectly feasible, even over large areas, and the expense of such extermination will hardly exceed one per cent of the losses which would otherwise occur during the next year. Yet it is hardly possible to completely exterminate the loco in an affected district with one year's digging, as some plants will be unavoidably missed, while others may spring from seed pods scattered, so that several diggings may be necessary. Loco should always be dug during May and June when in bloom, as its numerous flowers serve to point it out and, being dug at this time, prevent it from setting seed.

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### LUPINE.

There can be no doubt of the poisonous nature of the lupine although it is certainly one of the best forage plants in the state and not eaten in its dangerous condition. At least four of the species have been found poisonous, *Lupinus cyaneus* Rydb., *L. leucophyllus* Dougl. (Fig. 2), *L. sericeus* Pursh and *L. psoralea* Rydb., and it is probable that all are more or less so. All lupines all have blue, pea-like flowers and bean-like pods, with the name "prairie pea," "prairie bean," "blue bean," etc. The lupine is a perennial and often somewhat creeping beneath the ground; the plants are two or three feet high with six or eight narrow leaflets arising from a single point on the leaf-stalk. The more dangerous species of the Upper Yellowstone, (*L. cyaneus*) grows in dense clumps from a single thick root, often thickly scattered over corn fields and areas, and appears to be spreading rapidly. *L. Cyaneus* is found in valleys and along streams and its distribution is almost co-extensive with the so-called "loco zone," fruiting about July 1. There are more abundant in the foothills east of the Divide, but a few have caused losses in the Deer Lodge valley and in the valley of the Yellowstone. *L. sericeus* and *L. psoralea* are more common in the Elliston and the species occur throughout the whole northern section of the state. The principal species mentioned bloom early in June and are in fruit some three weeks later. The horses are the main sufferers although horses appear to be occasionally affected.

In the case of the lupine the conditions of poisoning are similar to those of the loco and most cases of such poisoning seem to be due to tra-



Fig. 2. LUPINE.

$\frac{1}{2}$  Natural size.

*Lupinus leucophyllus* Dougl.  
(U. S. Dept. Agriculture.)

sheep to new and unfamiliar ranges where lupine is abundant turning them into lupine fields when very hot or hungry or inducing them to fill up on the wet plants after rains. Sheep on these ranges and under ordinary conditions can graze on the lupine with impunity, but in case of long continued rains or late snows, they are apt to eat the lupine to excess and suffer from bloat or poisoning. It is a general impression that they become immune to the poison by becoming gradually accustomed to it and there is considerable evidence to support this view. Mr. Burke, of Great Falls, reports that sheep fed regularly on hay nearly half lupine were unaffected, while others eating the same hay for the first time died in considerable numbers, and several similar cases have been reported. Such instances have occurred of imported sheep being turned into lupine pastures with fatal results while the native sheep in the same pastures were not affected.

Enormous losses, more than a thousand in a number of instances, have been sustained by unloading sheep from the cars in transit on these lupine ranges when the plants were in fruit. Some sheep are often poisoned too by eating lupine hay or hay containing as much as 50 per cent lupine, which has been cut while in seed; yet sheep fed to cattle has caused no bad effects. There is no doubt that the poison being derived from the fruit, though the wet plants frequently cause fatal bloat. Most if not all cases of poisoning of stock in winter by plants on the ranges are due to lupine.

Stock poisoned by lupine appear to become blind and they move off staggering in straight or curved lines and with any obstruction will butt against it with spasmodic leaps, thus frequently pile up against fences or banks and lie there. There is often more or less frothing and the head is sometimes turned sideways; they are apt to fall over on their sides and kick at the ground, but some drop dead without exhibiting previous symptoms. It is little bloat necessarily, although bloat sometimes results from eating the plants, particularly when wet, or eaten to excess, but it is accompanied by the poison or may result fatally without any of the symptoms being shown. The "crazy loco" about Ft. Bellevue appears to be a form of lupine poisoning.

In the case of the Lupines, as in most other kinds of plants, prevention is better than cure and a knowledge of the usual conditions of poisoning will enable the sheepmen and herders to avoid most of the losses due to these species. As a general rule **do not feed sheep in on lupine when they are not accustomed to it, or when it is wet or when they are very hungry, for if they fill up on**

alone it is apt to prove indigestible and cause fermentation and bloat, particularly when wet, just as, indeed, will alfalfa or clover, in like condition, while the seeds or beans of the lupine contain an active poison of which it takes much less to fatally affect sheep unaccustomed to them than those that have been eating the seeds regularly. Also in feeding hay containing lupine, at first mix with other hay free from it, afterwards the amount of lupine contained can be gradually increased without any ill effects, but in any case such hay found poisonous to sheep can be fed to cattle without any danger. It is probable that nearly all poisoning from hay in this state arises from the lupine found in it, but several cases have been noted where the water-hemlock was so abundant in hay cut in low ground, as to seriously affect horses fed from it.

Herders and others charged with the care of sheep should not turn hungry sheep upon a lupine range at any time, especially when it is in fruit, and should keep sheep off such ranges when the lupine is wet and should graze them there with care in times of early snows, while in moving sheep from a range free from lupine to another containing it, they should be allowed to graze on the lupine at first but sparingly, but after they become accustomed to it no special care will be necessary even after it is in seed. Knowing thus the conditions of poisoning, it is quite possible to avoid nearly all the losses occasioned by it.



Fig. 3. WATER HEMLOCK.  
1/3 Natural size

*Cicuta occidentalis* Greene.  
(U. S. Dept. Agriculture)

**WATER HEMLOCK OR WATER PARSNIP.**

*Cicuta occidentalis* Greene.

This plant is allied to the cultivated parsnip and resembles it to some extent. It is often three or four feet high and has a smooth, green, ribbed, hollow stem spreading above and each branch terminating in an umbrella-like expansion of small white flowers (Fig. 3). It arises from a bunch of thick tuber-like roots which contain a yellow gummy secretion and are the chief seat of the poison, although the seeds have been reported to be more or less poisonous as well as the foliage in less degree. This species is frequent throughout the Rocky Mountain region, but other and equally poisonous species replace it in other parts of the United States. In Montana it is found in wet or swampy places along streams and ditches in the mountainous sections of the state, occurring but rarely in the plains eastward. It is often found in considerable patches in open marshy places, but usually occurs scattered sparingly along streams and ditches, by whose waters its seeds are disseminated. The roots of this plant have long been known to be a deadly poison and have been used by the Indians for suicide. The roots and foliage are also thought to be more poisonous in early spring than at other seasons and the semi-persistent basal leaves then attract stock seeking everything green and the roots are frequently pulled up or dug up from the soft ground and eaten with fatal results. It is said too that these roots on being tramped and crushed by sheep and other stock seeking water, exude a yellowish gummy liquid, which floats on the water and, being drunk with it, may affect stock fatally. The mature plant is far less poisonous, particularly when dry, yet a number of cases have been reported where stock have been poisoned in winter from eating "slough hay" of which this water hemlock was one of the chief constituents. Cattle and horses are the most frequent sufferers, but sheep also appear to be poisoned occasionally, though some authors report them as immune. This root is not infrequently mistaken for that of the edible "squaw root" (*Carum Gairdneri* Gray) with often fatal results to whites and Indians alike.

The poison contained in the root is rapid and deadly, death often resulting within a few hours after it is eaten, but where less of the root is taken the animal may linger along for several days or even eventually recover. The principal symptoms are violent convulsions, frothing at the mouth and nose, excessive urination, shallow breathing, coma and death. An examination of the body after death will usually show the lungs congested with blood and the lining membranes of the stomach and intestines more or less decomposed.

It is usually easy to determine this water hemlock poison by



Fig. 4. DEATH CAMAS. *Zygadenus venenosus* Wats.  
Half natural size.

fact that few animals get poisoned at a time and then always in wet places, the victim not being apt to get far from the locality poisoning. It is not at all difficult to dig up and remove all the plants of this species in pastures and enclosed ranges. The roots are relatively shallow, being rarely over six inches beneath the surface, and can readily be removed with a spade or hoe and then could be carried away, piled in heaps and burned when dry, as to have them scattered along the streams only makes them more available to stock. A few years ago the water hemlock was thus dug up and removed from the Daly ranch in the Bitter Root valley since then there seems to have been no trouble from this cause. The usual remedy employed and the one most available and effective seems to be to drench the animals affected with melted lard or kerosene grease.

### DEATH CAMAS.

#### *Zygadenus venenosus* Wats.

The Death Camas, also called Wild Onion, Wild Leek (Albermarle and Crowfoot, is an onion-like plant, arising from a bulb and bearing narrow leaves and a single stem a foot or so high, with a terminal spike of yellowish white flowers blooming about June 1 (fig. 4). No part of the plant has the smell or taste of the onion. The plants appear singly scattered over the upland swales or dry slopes, where it is often found in the greatest profusion over extensive areas, which are white with its flowers during the period of blooming. It matures its fruit soon after blooming and early in the fall it dies down to the ground again.

This plant is native from Assiniboia and Nebraska westward to the Pacific Coast and is found throughout the entire state of Montana, but is not sufficiently abundant to be dangerous to stock except in the foothills east of the divide and on the high upland benches of the plains. West of the Divide it is scattered sparingly throughout most of the region below 5,000 feet, but I am not aware that it has caused any trouble in this section.

The chief period of danger in the case of death camas is in May and June, when its great abundance over certain "poison zones" and its rank, dark-green leaves frequently cause it to be eaten to excess by the bands of sheep grazed in such sections. The bulb is the most poisonous part of the plant, but the sheep appear to be poisoned only by eating an excess of the stems and leaves, as it is difficult to pull up the bulbs even when the ground is soft from rain or melt-snow and it is usually the case that several hundred get poisoned at the same time. Sheep after having been grazed several hours on grass are often then grazed over these fields of death camas with impunity. The poisoning usually occurs when the sheep are turned hungry upon these poison belts and allowed to fill up on the death camas before reaching grounds where grass is more abundant.

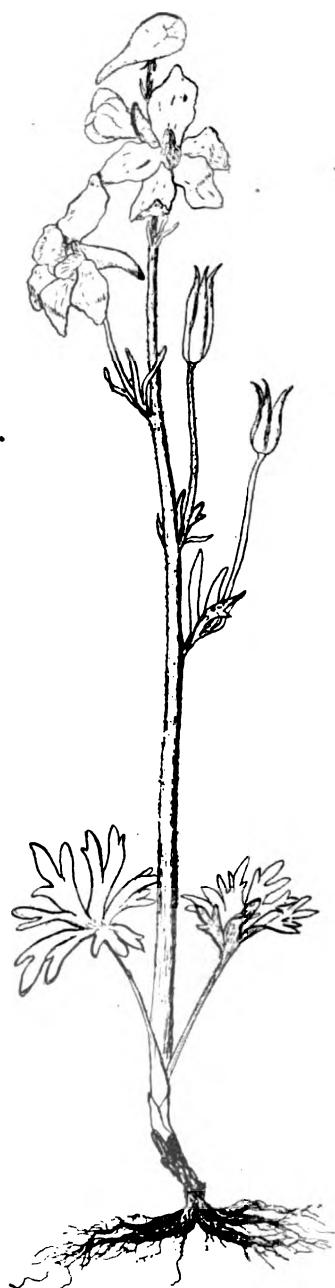


Fig. 5. SMALL LARKSPUR.  
*Delphinium Menziesii* DC.  
Half natural size.

Apparently sheep alone are apt to be poisoned by this species. They first become stiff in the legs and have trouble in walking, later exhibit difficulty in breathing, stagger, foam at the mouth and nose with a jerking of the head and limbs in intermittent spasms, falling finally in complete muscular paralysis and death. The poison seems to affect chiefly the voluntary muscles, causing paralysis which finally affects the organs of respiration, causing congestion of the blood in the lungs and death. Lambs are said to be affected by milk of a ewe suffering from the poison. The popular remedy for poisoning by death camas is bleeding in the extremities, usually in the mouth or tail and this has often been found effective in the early stages of the poison, but later it is difficult to make the blood flow. The philosophy of this treatment has not been explained by veterinarians, but the remedy seems to be in general use for both death camas and larkspur.

To prevent poisoning by death camas it is only necessary that care be taken by the herder not to graze his sheep in the swales and places where this plant is abundant, particularly during May and early June. The presence of the plant can easily be detected by the darker green foliage of the onion-like leaves, which come up before the grass and its identity can be determined by digging to the bulb, while the prominent white flowers easily distinguish it after it comes into bloom. There is little danger of poisoning by death camas after the middle of June, as the plant dies down to the ground soon after. The localities on the ranges where the plants are found in abundance should be noted and avoided during these two months.

### LARKSPUR.

Under the name Larkspur, or Aconite several related plants are designated in Montana. They all have blue or bluish flowers and rounded divided leaves and the poison, the same in all, is located mainly in the root—in fruit and foliage in less degree.

The Little Larkspur, *Delphinium Menziesii* DC. (Fig. 5), and the bicolor Nutt., is about a foot high and has bright blue spurred flowers. It comes up in early spring as soon as the snow is off the ground and is found in the foothill uplands in the greatest profusion along the breaks and hillsides of the plains eastward and over most of the mountainous parts of the state up to 8,000 feet. In many places it is found in similar situations with the death camas, and blooms and dies about the same time, while its symptoms are so similar that it is often difficult to discriminate between the two. The roots of the first species are tuberous clustered and only a few inches beneath the surface, so that cattle appear to pull them up occasionally after rains when the ground is soft, or, like the sheep, where there is a great abundance of the plants, they appear to eat them to excess



Fig. 6. LARGE LARKSPUR.  
Parts  $\frac{1}{2}$  natural size.

*Delphinium glaucum* Wats.  
(U. S. Dept. Agriculture.)

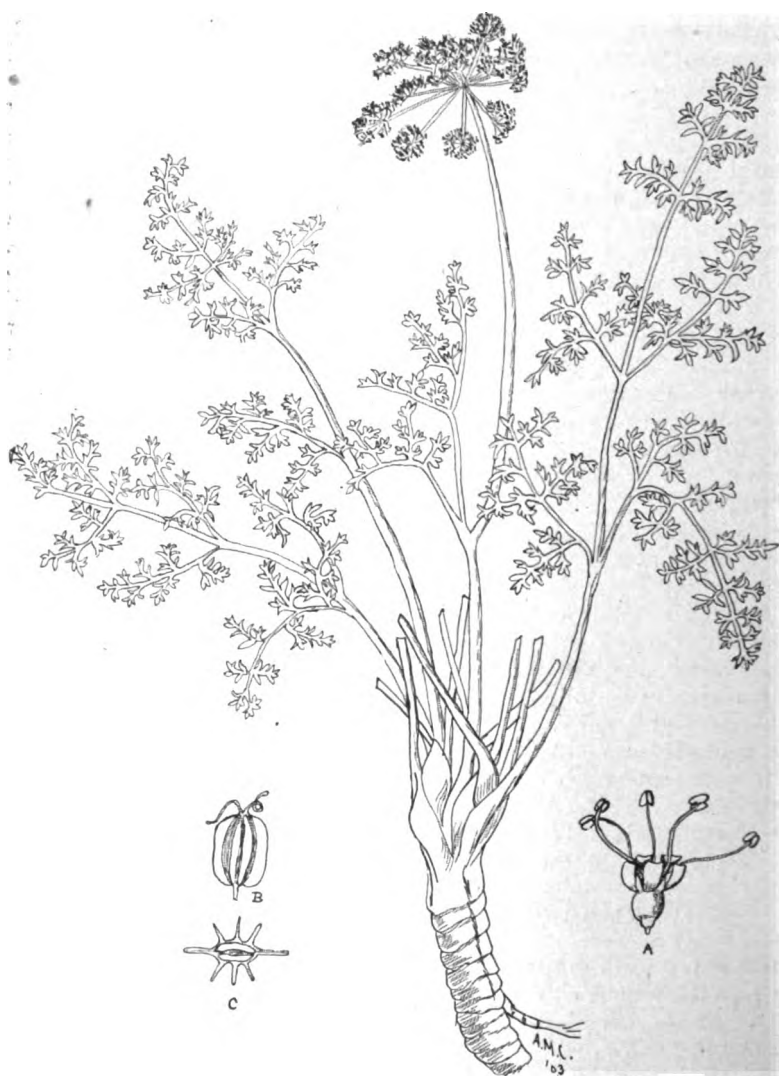
and suffer from poison or bloat in consequence. Yet it seems probable that the larkspur frequently suffers for the sins of its companions and that from the similarity of situation and symptoms much of the poisoning attributed to it may be due to the death camas and the wild parsnip.

The Large Larkspur (*Delphinium glaucum* Wats.) is much less abundant and is distributed over a much narrower range of territory in this state, apparently being found along mountain streams and in mountain meadows from 4,500 to 8,000 feet in the region east of the Divide, where in some places it is relatively frequent and its tall juicy stems and foliage serve to attract stock when driven to these ranges, particularly in times of late snows. This is a tall species three or four feet high, growing along streams and in shady hillside thickets and has light blue or nearly white flowers (Fig. 6), coming into bloom in June, after which there is not much danger of poison from this source. This appears to frequently cause bloat as well as to be a source of poison to cattle, other animals being rarely affected.

Along with these species of larkspur and usually confused with them is the true Aconite (*Aconitum Columbianum* Nutt.), which is rare in Montana, but is found along streams high up (6,500 to 8,000 feet) in the mountains on the south and west boundary of the state, where stock occasionally get it in passing across the range. This resembles the tall larkspur in size and leaf, but has blue spurless flowers and the foliage is said to be very poisonous.

Larkspur, particularly the large larkspur, is frequently the cause of bloat, and the animals affected may or may not also exhibit symptoms of poison. When the roots are eaten, or even considerable of the stems and foliage, animals exhibit stiffness in their legs and show difficulty in walking; they lag behind and lie down. There is a spasmodic twitching of the muscles of the sides and legs with convulsions in the final stages. As in the case of the death camas, the poison affects mainly the heart and organs of respiration, giving reduced pulse and shallow breathing, ending in convulsions and death. Cattle are mainly affected, sheep more rarely. The popular remedies are bleeding at the extremities, in the mouth or tail, and drenching with melted lard, or when this is not convenient, strips of fat bacon are forced down their throat.

It will usually be found possible to keep stock away from ranges where the small larkspur is so abundant, at least during the early spring when it is dangerous, while in mountain pastures it is feasible to dig up the large larkspur over limited areas, as it nowhere is found in any great abundance like the small species, but stock of all kinds should be looked after during periods of rain or after late snows, when they are more apt to get poisoned.



**Fig. 7. WILD PARSNIP.**

Half natural size.

*Pteryxia thapsoides* Nutt.

### WILD PARSNIP OR WILD PARSLEY.

In the spring of the year complaints constantly reach the Station of stock being poisoned on the high ridges and dry upland breaks of the foothill region east of the mountains and to some extent eastward. Investigation has been made of a number of localities of such poisoning and stockmen have been consulted as to the plants suspected and it appears that at least two species of the parsnip family must be held responsible, *Leptotaenia multifida* Nutt. and *Pterixia thapsoides* Nutt., the latter figured in Fig. 7, which may also very well represent the early stages of *Leptotaenia*. These are found here on dry, rocky ridges and dry hillsides in loose soil. Both species have thick, deeply penetrating roots and send up a cluster of finely divided leaves in early spring before the other plants have come up, so that cattle in particular, are tempted by their green attractive appearance. Yet, it is probable that their chief poison lies in the root, which often projects more or less above the surface so that it can be bitten off. The *Leptotaenia* usually begins blooming when less than six inches high, but is two or three feet high when in mature fruit. The *Pterixia* also begins blooming when only a few inches high and grows finally to a foot or more. Both have small yellow flowers and can not be distinguished in their early stages except by the botanist. The evidence of the poisonous nature of these two species, while not conclusive, is so strong that care should be taken to prevent stock from access in early spring to pastures where these plants are found in abundance.

The symptoms of this poison are much the same as those of the water hemlock. There is stiffness of the legs in walking, froth at the mouth, convulsions followed by death, often accompanied with bloat. The exact nature of this poison and accompanying symptoms need further study. These plants can be easily dug up in pastures, and enclosed ranges. Milk is said to be useful as an antidote.

### POISONING BY ALKALI.

It is necessary to distinguish this kind of poison from that caused by plants, with which it is often confused. There can hardly be any doubt as to the fatal effects of concentrated alkali water or of alkali salts when taken in excess, particularly by animals coming in from ranges where such salts are not abundant. Stockmen are practically agreed as to the danger from this source and certain "poison ponds" in the eastern part of the state seem to have no other characteristic except that of being surcharged with alkali, but the subject has been but little studied as yet and it is not always possible to distinguish between this and the various plant poisons.

In general the excess of alkali will result in bloat, often followed

by scours and there is usually a well marked froth and a deposit of an alkali-like substance about the mouth and nostrils. Sometimes the effect of such alkali water seems to be to hasten the action of the poison of the death camas in the stomach and the symptoms are then those of the latter, but are not developed before drinking the water and appear to result from it.

This poisoning by alkali is limited to certain localities in the eastern part of the state, where there is much alkali in the soil and water and the poisoning occurs in the later summer or during winter thaws, when the water collects in the alkali flats and may then be drunk to excess by stock in need of salt.

Salting stock regularly is thought to prevent this trouble and animals when first turned on alkali ranges, should be kept from the more stagnant pools, till they become accustomed to the dilute form of the salts. The remedy is simply to keep them away from such ponds and give them pure water till they recover, or in case of bloat, to treat them for such.

### REMEDIES.

As yet, practical methods for treating these different plants poisonings have not come into general use and most of the remedies recommended are in their experimental stage. All that will here be attempted will be to enumerate the various remedies proposed or found effective in the given cases.

For bloat in its more dangerous form "sticking" is the usual remedy for sheep and cattle. This is accomplished by plunging a wide-bladed knife directly into the stomach and thus allowing the accumulated gas to escape. The point where the incision is made is on the left side about half way between the hip bone and the ribs and is usually designated by being the point of greatest projection. There is little danger of making any serious mistake and animals thus treated usually recover without further attention. Horses can not be treated by this method. The regular instrument designed for this operation of rumenotomy is the trochar and canula which can be ordered by any druggist and will be found useful in the case of cattle, but sheep are frequently affected in such numbers that the knife is the only resource.

For the various kinds of actual plant poison the remedy generally recommended is permanganate of potassium, which can be purchased at drugstores in the form of reddish-purple crystals which are readily soluble in water and should be thus given. A teaspoonful of the crystals dissolved in water is enough for about 12 sheep or 4 cows. Wilcox recommends giving this with an equal amount of sulphate of aluminum (alum) in order to secure the best results.

This is put up by Dr. Emil Starz, Helena, Mont., in conve

ient 10-grain tablets under the name of "Ozonine" popularly called "Starz' Tablets," which are highly recommended by those who have used them. Some even report giving them dry to sheep for death camas poison with good results. Dr. Starz also recommends similar tablets composed of potassium permanganate, ammonium chloride and sodium carbonate, which when dissolved in the stomach give off ammonia as a cardiac stimulant. Some stockmen in Meagher county report having used a dilute (125 to 1) form of the sheep-dip "Zenoleum" (Zenner Disinfectant Co., Detroit, Mich.) for bloat and lupine poisoning with fair success, but neither of the remedies have been tried by this Station.

Of the more common remedies employed, melted lard, bacon grease or the bacon itself have been found effective in many cases of larkspur, water hemlock and other poisons, and is worthy of trial for all such poisons except loco. Milk appears to be sometimes used in a similar way. Decoction of tobacco and a solution of alum have been used successfully for lupine and Dr. M. E. Knowles recommends raw linseed oil for lupine and larkspur. Bleeding is practiced extensively for poisoning by death camas or larkspur, and is highly recommended by those that have tried it, but this is of doubtful benefit for water hemlock, wild parsnip or lupine. Just what action the bleeding has, or whether it is of any real benefit, the veterinarians appear doubtful, yet it seems possible that where death results from congestion of the blood about any organ, this congestion may possibly be relieved or prevented from proving fatal by such bleeding. Certain it is that this remedy is frequently practiced in the cases mentioned and with apparently beneficial results. The experimental study of the effects of these plant poisons and their remedies by a competent veterinarian is now imperitatively demanded by the stock interests of the state and, indeed, of the whole West.

The following provisional scheme is offered to determine the plants usually causing any given case of poison.

## SYNOPSIS OF POISONS.

### CATTLE.

#### Poisoned in low ground:

Convulsions, frothing, excessive urination; occurring mainly in early spring.....**Water Hemlock.**

Bloat, scours, alkali froth; occurring in late summer or during winter thaws ..... **(Alkali.)**

#### Poisoned on uplands or along mountain streams:

Bloat or stiffness in legs, twitching of muscles in sides and legs, shallow breathing, convulsions; in April, May or June, ..... **Larkspur.**

#### Poisoned on dry rocky ledges, on high ridges or on dry hillsides:

Bloat, stiffness of legs, convulsions, frothing; in April and May ..... **Wild Parsnip.**

### HORSES.

**Poison slow**, rendering them stupid, sight affected, crazy when tired or hot ..... **Loco.**

#### Poison rapid in action:

Blind and frenzied, spasmodic convulsions; July and August or from lupine hay in winter..... **Lupine.**

Convulsions, frothing, excessive urination, coma; in low ground; April and May.....**Water Hemlock.**

Bloat, scours, alkali-like froth; in late summer or during winter thaws.....**(Alkali.)**

### SHEEP.

**Poison slow**, rendering stupid, front teeth long, inclined to wander from herd; lambs and yearlings mainly.....**Loco.**

#### Poison rapid in action:

Bloat, or blind and frenzied, pile up against obstacles, spasmodic convulsions; in July and August or from lupine hay in winter, or after snow or rain.....**Lupine.**

#### Poisoned along streams:

In early spring, or from "slough hay" in winter; convulsions, frothing, excessive urination, coma.....  
**Water Hemlock.**

In late summer or during winter thaws; bloat, scours, alkali-like froth ..... **(Alkali.)**

#### Poisoned in swales, on high benches or in foothill valleys:

Stiffness in legs, convulsions, final paralysis; many affected at once; May and June.....**Death Camas.**

#### Poisoned in foothills or along breaks, and mountain streams:

Twitching of muscles in sides and legs, stiffness of gait, occasionally bloat, final convulsions; few poisoned at once; in May and June.....**Larkspur.**

#### Poisoned on high rocky ledges or high dry ridges in early spring.

Bloat, stiffness of legs, convulsions, frothing; few poisoned at once.....**Wild Parsnip.**

### SUMMARY.

1. More than 90 per cent of all cases of stock-poisoning by plants in Montana can be traced to some six groups of plants--the loco, lupine, water hemlock, death camas, larkspur and wild parsnip, and most of the losses resulting may be avoided by a knowledge of these plants and of the conditions under which such poisoning occurs.

2. The loco habit is usually acquired by lambs and colts in May and June, when the plant is in bloom and they are first learning to graze. Old sheep and horses rarely become locoed, unless range is short and the loco abundant.

3. The loco plant can be exterminated by digging the plants with a hoe while they are in bloom in May and June, cutting the main root below the crown and some two or three inches beneath the surface.

4. Lupine is dangerous if eaten in excess when wet, or when sheep are hot and hungry or when they are not accustomed to it, and it is particularly poisonous when the seeds are mature, if eaten in quantity or by sheep not accustomed to this diet. Cattle appear not to be affected and horses but rarely. Under normal conditions the lupine is an excellent forage plant.

5. Water Hemlock poisons horses and cattle chiefly and may be easily destroyed by digging it up along the streams and ditches. It is most dangerous in early spring.

6. Death Camas causes extensive losses among sheep in the spring in certain "poison zones" in the foothills and on the high benches east of the Divide. Herders should keep their bands away from localities where the plants are abundant, particularly when they are hungry. After July 1 there is little danger as the plants then fruit and die.

7. The Larkspur is found in much the same situations as the death camas and the same rules will apply as for the latter.

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BULLETIN No. 46,

MONTANA AGRICULTURAL

# Experiment Station,

— OF THE —

**Agricultural College of Montana.**

## TWO INSECT PESTS.

**Bozeman, Montana, June, 1903.**

REPUBLICAN,  
Bozeman, Montana,  
1903.

# MONTANA AGRICULTURAL Experiment Station.

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Bozeman, Montana.

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# Montana Experiment Station.

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BULLETIN NO. 46.

JUNE, 1903.

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## TWO INSECT PESTS.

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R. A. COOLEY

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### THE ROSEBUD CURCULIO

*Rhynchites bicolor* Fab.

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The rosebud curculio occurs very commonly on wild and cultivated roses in Montana. The beetles are rather shy when discovered, and though their movements are not quick, they soon disappear under a leaf or stem when a person approaches. In common with many other insects, they have the habit of drawing in their legs when in danger and allowing themselves to drop to the earth, where they remain motionless for a short time, or until the danger has passed. This is doubtless an effective means of protection against natural enemies.

The colors found on the beetle are red and black. The wing covers, which make up the greater part of the upper surface of the body, and the thorax (prothorax) are red, while the head, including the beak or snout, the antennæ, the legs, and the entire under surface of the body are black.

Mr. F. H. Chittenden, an Assistant Entomologist in the United States Department of Agriculture, reports\* that in Colorado specimens are found in which the greater part of the head, legs and antennæ are red like the upper surface of the body.

The beak or snout is long and slender, as indicated in the accompanying figure (Fig. 1. a. and d.). The antennæ are club-shaped and are attached near the middle of the snout, one on each side. The mouth parts are situated on the extreme end of the beak, and are made up of a number of pieces, the most formidable of which are the mandibles, which are toothed on both the inner and outer edge. The mouth parts viewed from beneath are illustrated in Figure 1, g. Exclusive of the beak the beetle measures a little less than one-fourth of an inch in length.

The injuries for which the species is responsible are done by the adult or beetle, and so far as is known by the writer, the larva, though it feeds in the fruit of the rose, does no harm to the bushes in any way. The principal injury accomplished by the beetle is done by boring small, deep holes into the buds. Many holes are often bored into a single bud. Though such a bud may open, the resulting rose is of no value. Other buds cease to develop when eaten into and soon wither and dry up. The beetles also bore holes into the stems of the roses at right angles to the axis. Buds affected in this way wilt, and hang from the stems, and later dry.

We have not been able to see any particular significance in the boring of holes into the stems, though when we began the studies it was thought possible that the buds were caused to wilt and dry for the purpose of preparing a suitable food for the young. Though very

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\* p. 99, Bulletin Division of Entomology, New Series, No. 27, 1901.

many such buds have been broken open and examined, we have never found a larva feeding in one.

Complaints of the injuries caused by this beetle have reached the Experiment Station from various parts of the State, particularly from Kalispell, Missoula and Bozeman. The injuries are scarcely less serious and extensive than those of the rose chafer, (*Macrodactylus*

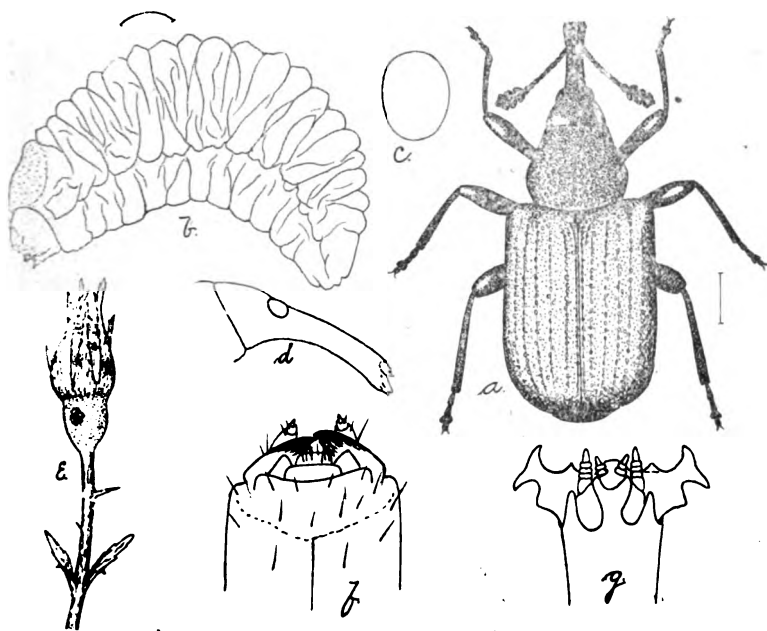


Fig. 1. ROSEBUD CURCULIO—*a.*, adult beetle; *b.*, larva; *c.*, egg; *d.*, sideview of head of beetle; *e.*, bud injured by the beetle; *f.*, mouthparts of the larva; *g.*, mouthparts of the beetle. (Drawings by the writer.)

*subspinosus*) in the Eastern States, and a number of cases have come under the writer's attention in which persons have given up an attempt to grow roses on account of the injuries of this insect. We have received no reports of injury by this insect on green-house roses.

The species is a native one and has been found by the writer on wild roses far into the mountains in Montana. Various writers have

reported it as a troublesome pest on roses in widely separated parts of the United States. It occurs in the northern tier of States from ocean to ocean and as far south as Mexico.

Mr. Alexander Craw, Quarantine Officer and Entomologist of the California State Board of Horticulture, has mentioned this species as being frequently found eating into ripe blackberries and raspberries which it causes to decay.

The beetles appear on the bushes early in June and continue until the latter part of August. The eggs are deposited in various places. Most of those found by the writer were in the buds, either in the unexpanded petals or in the young fruit. One egg was found in the tender extremity of a new cane and one in a Cynipid gall. In all cases the eggs were found in the holes made with the beak, and were placed well down in the holes, below the surface. The form of the eggs is shown at c, Fig. 1. They are semi-transparent and almost colorless.

The eggs hatch in a few days, probably about a week or ten days. We have never been able to find larvæ except in the rose hip or fruit, and this is doubtless the normal place for their development.

They feed upon the seeds which fill the greater part of the cavity of the fruit. The fleshy coating of the fruit is not eaten so far as we have observed. Examination of a fruit containing a nearly full grown larva shows a part or all of the seeds excavated to mere shells and the body of the larva buried in a mass of waste and excrement. Such a fruit shows a blackened scar on the side which marks the spot where the parent beetle bored in to deposit the egg.

The larva or grub (Fig. 1, b.) is yellowish white with a rosy tint and instead of being straight has the back arched. It has no legs. The head and mouth parts viewed from above are shown at Fig. 1, f.

We have never found the larvæ in abundance. A large bush bearing many hips seldom has more than two infested fruits, though

many may have the external mark that would indicate them to be infested.

The grubs finish feeding and disappear early in October. We have never found the larvæ or pupæ in winter quarters and are not informed as to how they pass the winter. We examined many rose hips that have been occupied by larvæ and found exit openings in the side of the fruit, and the grubs gone. This would seem to indicate that, when full grown, the larvæ eat holes to the surface and go to the ground to pupate and pass the winter.

In the Bitter Root valley and at Bozeman the writer has repeatedly found the larva of a moth tunnelling in the new canes of wild roses, and at Missoula and Hamilton we have had complaints of what appears to be the same insect on cultivated varieties. The larva begins at the tender extremity of the shoot and bores downward in the center of the stem, thereby killing it and seriously interfering with the normal development of the bush. This insect should not be confused with the rosebud curculio.

### REMEDIES.

In many cases hand picking is all that is necessary to get relief from the injuries caused by this insect.

In a previous paragraph we have mentioned the fact that when disturbed the beetles drop to the ground. Taking advantage of this one can catch the beetles by holding a hand, or better, a pan containing kerosene underneath and causing the beetles to drop.

Under some conditions hand picking is a futile measure. When the cultivated roses to be protected are in the vicinity of wild roses which breed the beetles year after year, it will probably be useless to attempt hand picking. Under some circumstances it may be profitable to destroy wild roses that furnish a breeding place. In general, however, it should be borne in mind that the beetles fly over a considerable distance and that until fence corners and waste lands of the

surrounding country are cleaned of the native roses, more trouble will always be experienced.

It is said that a spray of Paris green will kill the beetles.

# THE POPLAR LEAF-FOLDING SAWFLY.

*Pontania bozemani* Cooley.

---

The various native and introduced poplars easily take first place as shade and ornamental trees for Montana, and they far outnumber all other kinds now in use in the State. The leaf-folding sawfly is one of the most troublesome and widespread of the many species of insects that feed upon these shade trees. For the past few years this insect has been steadily increasing in numbers and during the summer of 1902 was very commonly seen. In a few cases trees were found with nearly every leaf deformed, and in the residential parts of some of the towns and cities of the State it has been so abundant as to very greatly injure the natural beauty of the trees.

This insect appears to be native to the State and occurs in natural growth along streams as well as in trees used for shade.

A close study of adult specimens showed them to belong to an undescribed species, and we have therefore proposed the name *PONTANIA BOZEMANI*, after the city in which it first came under our notice. The writer's technical descriptions establishing the species are to be found in the current volume of the "Canadian Entomologist."

This insect makes its presence conspicuous by the manner in which it deforms the leaves. Affected leaves have their lateral edges turned under until they lie against the lower surface. See Fig. 2, g.

Both edges of the same leaf are often folded. The cavity in the fold is occupied by the larva.

The presence of the insect is objectionable not for any reason that is done to the health of the tree but because of the damage to the foliage.

The adult hibernates among the leaves on the ground, emerging in the month of May, lays its eggs on the young leaves just being put forth. The new shoots of the poplars continue to grow through the summer months, and as they increase in length the leaves appear. The sawflies continue on the foliage depositing eggs through the month of July.

Although the writer has often examined the eggs in the pockets under the epidermis in the folds of the leaves, they were not seen in the act of depositing them until July 1, 1902, when the whole process was seen and recorded. While searching the woods on the college campus for evidence in the life-history of the insect, a female was seen going from leaf to leaf as if prompted by a distinct purpose. Different leaves were carefully examined by the writer and finally one was selected. The young, tender leaves previous to being expanded, have both the lateral edges rolled inward parallel with the midrib (involute), and it is on this roll, and hence on what is to become the under surface of the leaf that the sawfly works. Having selected the leaf the sawfly began at the end of the roll nearer the top of the leaf and proceeded slowly along to the other end repeatedly puncturing the tissue with the ovipositor. When at the other end of the roll, she turned around, and, without turning around, went through motions which indicated that she was laying an egg in the leaf, underneath her body toward her head. A slight breeze was blowing and causing her to move so the writer was able to take the stem in his hand and follow the whole operation closely without frightening the sawfly. The ovipositor could be distinctly seen both while making the punctures in the leaf and while depositing the egg. After the sawfly had left, the leaf was carefully examined with a hand lens and

almost the exact spot was known the egg pocket could not be found. The leaf was marked with a piece of white thread and going back later in the day the egg-pocket and egg were distinctly seen. The exact duration of the egg stage was not determined on account of absence from the college but was very close to nine days. Long before the egg hatched the leaf-fold was completed, thus making it clear that the adult insect was wholly responsible for the folding of the leaf.

The egg of this insect is long-ovate, about one-twenty-fifth of an inch (1.05 mm) in length and whitish in color. The egg (shown in

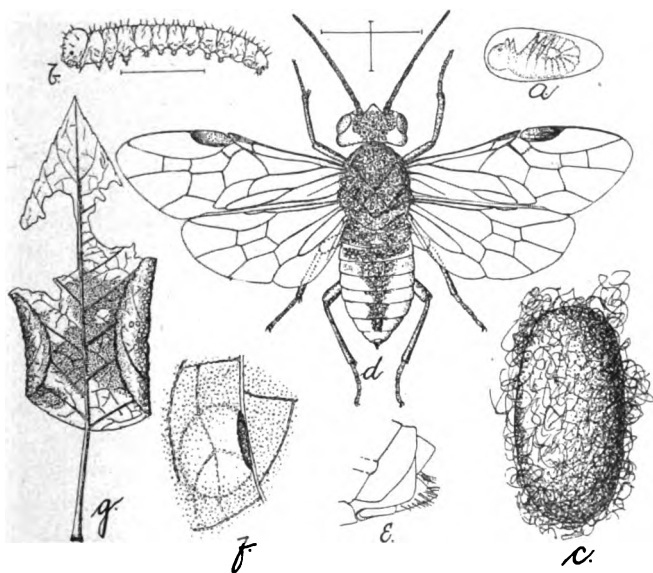


Fig. 2. LEAF FOLDING SAWFLY—*a.*, egg showing embryo; *b.*, immature larva; *c.*, cocoon; *d.*, female sawfly; *e.*, sideview of extremity of abdomen of female; *f.*, portion of poplar leaf showing the egg pocket under the epidermis; *g.*, leaf with the two edges folded under and other parts eaten away. (Author's illustration, first used in the Canadian Entomologist.)

Fig. 2 *a.*) had been kept in formalin for a few month and showed the nearly mature embryo as indicated in outline in the drawing. The young larva is at first very delicate and almost colorless, but later, as it grows larger, it becomes stronger and turns to a pale green color.

See Fig. 2, b. During its early life the larva feeds wholly from the inner surface of the portion of the leaf that is folded and forms its retreat, and this part soon becomes more or less skeletonized. When it has reached a greater size making more food necessary, instead of continuing to eat away the walls of its home, it ventures forth out of the end of the fold opposite from the petiole and eats holes through the leaf not stopping with the surface parts. The part of the leaf making up the fold and adjacent parts become blackened. The fold of the leaf is used as a hiding place throughout the larval life.

A very large proportion of the larvæ never reach sufficient size to begin feeding outside the fold of the leaf, though certain letters of inquiry about this insect from citizens of the State would seem to indicate that at times practically all come to maturity. In such cases serious injury to the foliage would follow.

During the first two years that the writer had this insect under observation, not a leaf was found that contained a larva more than a few days old. In fact, the usual injury throughout the State is only the folding of the leaves. We have found nothing to indicate the cause of the death of this large proportion of the larvæ. The vacated cavities later become inhabited by plant lice and various other insects and spiders.

A leaf folded by this insect and partly eaten is shown at g. in the accompanying figure.

When fully grown the larva constructs a cocoon in the fold of the leaf. This cocoon (Fig. 2, c.) is ellipsoidal in form, 8.-mm long and brown in color. The cocoon drops to the ground along with the leaf and is occupied by the insect until the following spring. The adult insect emerges from the cocoon in the spring and lays the eggs as already described.

The female adult insect (Fig. 2, d.) is a "four-winged fly" one-sixth of an inch (6.-mm) in length and resinous-yellow and black in color. The antennæ, a large spot on the upper side of the head, the

upper side of the thorax and a tapering stripe on the upper side of the abdomen, are glossy black while the remaining parts are, for the most part, resinous yellow. The male insect is slightly smaller, with a more slender body, and has the entire upper surface of the abdomen black.

The leaf-folding sawfly here discussed is a member of a large and important family of insects popularly called sawflies and scientifically known as the TENTHREDINIDÆ. About 2,000 species of sawflies are known.

Though we speak of these insects as "flies" or "sawflies," it should be understood that they do not belong to the true flies or DIPTERA to which order the common house-fly belongs. The sawflies have mouth parts for biting and chewing and are provided with two pairs of wings, while the true flies have mouth parts for lapping, or piercing and sucking, and have only one pair of wings.

Sawflies take their common name from the fact that the ovipositor of the female is so constructed as to resemble a saw. When not in use, the saw, or saws (for there are two of them), are enclosed in a sheath which in turn is situated in a longitudinal groove in the under side of the abdomen at the posterior end. The female uses this ovipositor to cut a slit or pocket in the soft tissues of plants in which to deposit the eggs. In the species now under discussion, and in many others, also, the egg is deposited just under the epidermis of the leaves which is very skillfully separated from the underlying tissues with the ovipositor.

Most sawfly larvæ so closely resemble caterpillars of moths and butterflies as to be easily mistaken for them. They may be distinguished, however, by the larger number of abdominal legs. Sawfly larvæ have from six to eight pairs while caterpillars usually have five or less.

The larvæ of most of the species of the genus PONTANIA, to which the poplar leaf-folding sawfly belongs, feed in abnormal growths called galls on the leaves. The only exception outside of the present species,

known to the writer, is one which rolls the tips of willow leaves and constructs imperfect galls. This species was described from York City by Mr. C. L. Marlatt of the United States Department of Agriculture.

### REMEDIES.

As has been stated, this insect is native to the State and commonly on the natural growth. This fact should be borne in mind in attempting to control it on trees planted for shade or ornamental purposes. When the trees are in the vicinity of natural growth and are infested, it will probably be impracticable to get the growth to the desired condition. It should be noted also that the only way to prevent the folding of the edges of the leaves is to destroy the adults before they begin to sting the leaves. The spraying that is suggested below will be of little use only in killing the larvæ and, therefore, in preventing them from coming to the foliage the following season.

Probably the most satisfactory results will be secured by spraying the leaves in the fall of the year. As we have previously stated, the insect passes the winter among these leaves and the utility of destroying the leaves.

Spraying the trees once or twice in July and August with Paris green or arsenate of lead would be useful in killing the adults that come out of the folds to feed. It is not necessary to spray the leaves with poison inside the folds for those that would come to maturity and come out of the folds to feed.



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### SUMMARY AND CONCLUSION.

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(1) For the lambs, the screenings proved the cheapest and most efficient grain ration, followed by mixed grain, wheat, barley and oats in the order named.

(2) The lambs ate 2.05 pounds of clover and .81 pounds of grain a day while the wethers ate 3.22 pounds of clover and .806 pounds of grain.

(3) The lambs averaged .263 pounds gain in live weight a day, or 25 pounds for the full term of the experiment. The wethers averaged .238 pounds per day or 22 $\frac{2}{3}$  pounds for the 95 days.

(4) The lambs ate 8.03 pounds of clover and 3.11 pounds of grain for each pound of increase in live weight. The wethers ate 13.49 pounds of clover and 3.38 pounds of grain for each pound of increase.

(5) Each pound of increase in live weight put upon the lambs cost 4.49 cents while each pound of increase on the wethers cost 6.3 cents.

(6) Lambs kept without food or water for 12 hours shrank nearly 2 per cent. Wethers similarly treated shrank 3 per cent in weight.

(7) In shipping to Chicago each lamb shrank 7 $\frac{1}{4}$  pounds or 7.6 per cent. On the average for three years they shrank 8.3 per cent of their shipping weight. The wethers lost 10.4 pounds each or 7.1 per cent of their shipping weight, or for two years, 7.8 per cent of their shipping weight.

(8) For the past winter it cost on the average 75 cents to ship and sell each lamb at Chicago and \$1.16 for each wether. On the average for three years it cost 78 $\frac{2}{3}$  cents to ship and sell one lamb and \$1.16 $\frac{1}{2}$  to ship and sell one wether.

(9) The net prices received for the lambs F. O. B. Bozeman was \$5.57 per 100 pounds live weight and for the wethers \$4.78 per 100 pounds.

(10) The profit, or return for money invested and pay for the labor, on each lamb, by shipping to Chicago was \$2.34 and the profit on each wether was \$2.80. Or taking the results of the practical feeder and charge 25 per cent for the labor cost of feeding, the return on the investment was \$2.09 for the lamb and \$2.55 for the wether.

(11) In the slaughter test the lambs dressed 54.8 per cent and the wethers dressed 51 per cent of the live weight at Chicago.

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Serial 35,35,7

**BULLETIN NO. 48.** ✓

**MONTANA**

**AGRICULTURAL**

**EXPERIMENT STATION**

--OF--

**THE AGRICULTURAL COLLEGE**

--OF--

**MONTANA.**

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**STEER FEEDING.**

**WINTER OF 1902-1903.**

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**BOZEMAN, MONTANA, SEPTEMBER, 1903.**

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**BOZEMAN CHRONICLE--1903.**



# MONTANA AGRICULTURAL EXPERIMENT STATION.

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**NOTICE**—The bulletins of the Station will be mailed to any citizen of Montana who sends his name and address to the Station for that purpose.

# EXPERIMENTS IN STEER FEEDING, 1902-3.

By F. B. LINFIELD.

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NOTE—Through an oversight, Bulletin No. 47 was paged independently of the other series of the year. This Bulletin returns to the consecutive paging

# STEER FEEDING.

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## INTRODUCTION.

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For the past three seasons the Montana Experiment Station has conducted experiments in fattening steers, to test the feeding value of various kinds of Montana fodders. During the past winter a carload of steers were fed, the object of the experiment being to determine the relative value of different kinds of grain when fed with clover in fattening steers. The question is frequently asked as to the relative value of oats, wheat, barley, etc., for fattening animals and this experiment was planned to throw some light on the subject.

The 24 steers used in the test were a mixed lot of two and three year olds, range stock of probably average quality. The most of them showed evidences of some little Short Horn blood. They arrived on the farm on the 23rd of November. On the 28th, one-half of the steers which were not dehorned, were driven to a dehorning chute and the horns sawed off. The wounds healed rapidly and with no apparent disadvantage to the steers.

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### PLAN OF EXPERIMENT.

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The 24 steers were divided into four lots, six steers in each lot. The division was made as evenly as possible considering quality and weight. The lots were fed as follows:

Lot 1. Wheat and clover hay.

Lot 2. Oats and clover hay.

Lot 3. Barley and clover hay.

Lot 4. Wheat, oats and barley mixed in equal quantities, by weight and clover hay. All the grain was chopped.

The experiment started on December 1st. For the first ten days clover hay was fed. We then started to feed the grain, giving three pounds per day to each lot and about one month was taken to get the steers onto a full feed of five pounds of grain per steer per day. The hay and the grain were fed twice in the day.

The steers were weighed on December 1st and 3rd, and again on the 10th and 12th of December, and thereafter every two weeks until the close of the experiment. The average of two days weights was taken as the correct weight.

Water was flowing through the yards, thus the steers had access to water at will. Salt was also kept on hand.

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### COST OF THE FEED.

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The cost of the grain and fodder fed was as follows:

Clover hay.....	\$5.00 per ton
Wheat.....	88c per 100 lbs.
Oats.....	85c per 100 lbs.
Barley.....	95c per 100 lbs.
Bran.....	85c per 100 lbs.
Mixed Grain.....	89c per 100 lbs.

These prices were practically the market prices for the hay and grain on the Bozeman market in the fall of 1902. The clover hay was of good quality and generally well cured. It was a mixture of medium red and alsike. The grain was good marketable grain.

TABLE I.—Weights and Gains of Steers.

Period	Lot and How Fed.	Weight at begin- ning of experiment and of each period.	Weight at end of periods and of test.	Gain for each period and total gain.	Aver- age daily gain per steer.	Aver- age gain per steer
		lbs.	lbs.	lbs.	lbs.	lbs.
First period Dec. 1st to Jan. 6th. 37 days.	1. Wheat and clover hay.....	6675	7040	365	1.64	60.84
	2. Oats and clover hay.....	6507	6830	323	1.45	53.84
	3. Barley and clover hay.....	6470	7002	512	2.40	88.63
	4. Mixed grain and clover hay	6702	7315	613	2.76	102.18
Second period Jan. 7th to Feb. 3rd. 28 days.	1. Wheat and clover hay.....	7040	7540	500	2.98	83.34
	2. Oats and clover hay.....	6830	7120	290	1.73	48.34
	3. Barley and clover hay.....	7002	7480	478	2.87	79.67
	4. Mixed grain and clover hay	7315	7875	560	3.33	93.34
Third period Feb. 4th to Feb. 24th. 21 days.	1. Wheat and clover hay.....	7540	7685	145	1.07	24.17
	2. Oats and clover hay.....	7120	7245	125	1.00	20.83
	3. Barley and clover hay.....	7480	7550	70	.55	11.67
	4. Mixed grain and clover hay	7875	7962	87	.69	14.50
Two periods from Jan. 7th to Feb. 24th. 49 days.	1. Wheat and clover hay.....	7040	7685	645	2.19	107.50
	2. Oats and clover hay.....	6830	7245	415	1.41	69.17
	3. Barley and clover hay.....	7002	7550	548	1.86	91.34
	4. Mixed grain and clover hay	7315	7962	647	2.20	107.84
Three periods from Dec. 1st to Feb. 24th. 86 days.	1. Wheat and clover hay.....	6675	7685	1010	1.96	168.34
	2. Oats and clover hay.....	6507	7245	738	1.43	123.00
	3. Barley and clover hay.....	6470	7550	1080	2.09	180.00
	4. Mixed grain and clover hay	6702	7962	1260	2.44	210.00
Fourth period Feb. 25th to March 21st. 25 days.	1. Mixed grain and clover hay	7685	8075	390	2.60	65.00
	2. Mixed grain and clover hay	7245	7635	390	2.60	65.00
	3. Mixed grain and clover hay	7550	7960	410	2.73	68.34
	4. Mixed grain and clover hay	7962	8387	525	3.50	87.50
Whole time Dec. 1st to March 21st. 111 days.	1. Wheat and clover hay.....	6675	8075	1400	2.10	233.35
	2. Oats and clover hay.....	6507	7635	1128	1.69	188.00
	3. Barley and clover hay.....	6470	7960	1490	2.34	248.36
	4. Mixed grain and clover hay	6702	8387	1685	2.53	280.83
	Average for 24 steers.....	26354	32057	5703	....	....
	Average per steer.....	1097	1336	....	2.15	239.00

TABLE II.—Food Eaten by Steers and Cost of Same.

Period.	Lot	How Fed.	Total Food Eaten.		Food Eaten Per Steer.		Food Eaten for One Pound Gain.		Cost of Feeding	
			Clover.	Grain.	Clover.	Lbs.	Clover.	Lbs.	Per Day Per Steer.	Per One Lb. Gain.
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cents.	Cents.
First Dec. 1 to Jan. 6 37 Days.	1	Wheat and clover hay.....	5435	512½	24.5	2.31	14.9	1.44	8.15	4.99
	2	Oats and clover hay.....	5440	511½	24.5	2.30	16.8	1.58	8.08	5.44
	3	Barley and clover hay.....	5440	508½	24.5	2.29	10.2	.95	8.3	3.45
	4	Mixed grain and clover hay..	5440	513½	24.5	2.31	8.7	.83	8.18	2.93
Second Jan. 7 to Feb. 3 28 Days.	1	Wheat and clover hay.....	4720	835	22.1	4.97	9.44	1.67	9.8	3.82
	3	Oats and clover hay.....	4720	840	22.1	5.00	16.2	3.24	9.8	6.80
	3	Barley and clover hay.....	4730	840	22.1	5.00	9.89	1.77	10.3	6.62
	4	Mixed grain and clover hay..	4720	840	22.1	5.00	8.42	1.5	10.0	3.44
Third Feb. 4 to Feb. 24 21 Days.	1	Wheat and clover hay.....	3675	492	29.0	3.9	25.3	3.39	10.68	9.30
	2	Oats and clover hay.....	3675	630	29.0	5.0	29.3	5.04	11.50	11.61
	3	Barley and clover hay.....	3575	630	28.4	5.0	52.5	9.00	11.85	21.67
	4	Mixed grain and clover hay..	3575	630	28.4	5.0	42.2	7.24	11.56	16.61
Two Periods from Jan. 7th to Feb. 24th 49 Days.	1	Wheat and clover hay.....	8395	1327	28.5	4.51	13.0	2.06	11.19	5.06
	2	Oats and clover hay.....	8395	1470	28.5	5.0	20.2	3.54	11.37	8.05
	3	Barley and clover hay.....	8305	1470	28.2	5.0	15.1	2.68	11.75	6.32
	4	Mixed grain and clover hay..	8295	1470	28.2	5.0	12.8	2.27	11.51	5.22
Three Periods from Dec. 1st to Feb. 24th. 86 Days.	1	Wheat and clover hay.....	13830	1839½	26.8	3.56	13.7	1.82	9.83	4.02
	2	Oats and clover hay.....	13835	1981½	26.8	3.84	18.7	2.68	9.96	6.945
	3	Barley and clover hay.....	13745	1978½	26.6	3.84	14.9	2.15	10.29	6.067
	4	Mixed Grain and clover hay..	13735	1983½	26.6	3.84	10.9	1.57	10.05	4.127
Fourth Period from Feb. 25th to Mar. 1st 25 Days.	1	Wheat and clover hay.....	4540	750	30.3	5.	11.14	1.95	11.98	4.501
	2	Oats and clover hay.....	4540	750	30.3	5.	11.14	1.95	11.83	4.442
	3	Barley and clover hay.....	4540	750	30.3	5.	11.08	1.83	12.33	4.508
	4	Mixed grain and clover hay..	4540	750	30.3	5.	8.65	1.24	12.03	3.260
Whole Time Dec. 1st to Mar. 21st. 111 Days.	1	Wheat and clover hay.....	18370	2589½	27.6	3.9	13.1	1.85	10.33	5.903
	2	Oats and clover hay.....	18375	2731½	27.6	4.1	16.3	2.42	10.38	6.132
	3	Barley and clover hay.....	18285	2728½	27.5	4.1	12.3	1.83	10.77	4.812
	4	Mixed grain and clover hay..	18275	2733½	27.4	4.1	10.9	1.62	10.51	4.176
		Average for 24 steers.....	73305	10783	27.5	4.05	12.8	1.9	10.5	5.206
		Average for 1 steer.....	3054	449	.....	.....	.....	.....	.....	.....

---

## DISCUSSION OF RESULTS.

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Tables 1 and 2 give the facts gleaned during the feeding test. The whole time of the feeding test is divided into periods so as to note any change in the weight or gain during the time of feeding. The first period of 37 days was really preliminary. For ten days of this time the steers received hay only, and the rest of the period was taken in getting the steers up to a full grain ration. None of the steers apparently, had ever seen grain before and it took a little coaxing to get some of them to eat it. We first started by mixing a little salt with bran, and later cut down the hay ration for a day or two. Finally all started to eat the grain except one steer in lot 3. This animal never ate any grain during the time of the test. His ration was eaten by the others.

The test period proper was for the next 49 days, but this is also divided into two periods, as it was noted that in the latter part of the period the steers seemed to be getting tired of the grain. Because of this fact the test proper was concluded after the steers were on feed 86 days, but the steers not being ready for market, all the lots were fed for 25 days longer, on a mixed grain ration with bran. The tables afford opportunity for several comparisons during the feeding season.

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## THE GAINS MADE.

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For the first period of 37 days, lot 4 gained the most, viz.: 2.7 lbs. per day per steer, with lot 3 in second place, gaining 2.4 pounds per day. Lots 1 and 2 gained nearly 1 pound less per day per steer. For the first part of the test period, viz.: 28 days, lot 4 gained 3.33 pounds per steer per day. This lot averaged 3 pounds per day for the 65 days feeding to this date. Lot 1 fed wheat jumps to second place with a gain of 2.98 or nearly 3 pounds per steer per day. Lot 3 fed barley, is a close third with the lot fed oats very much behind.

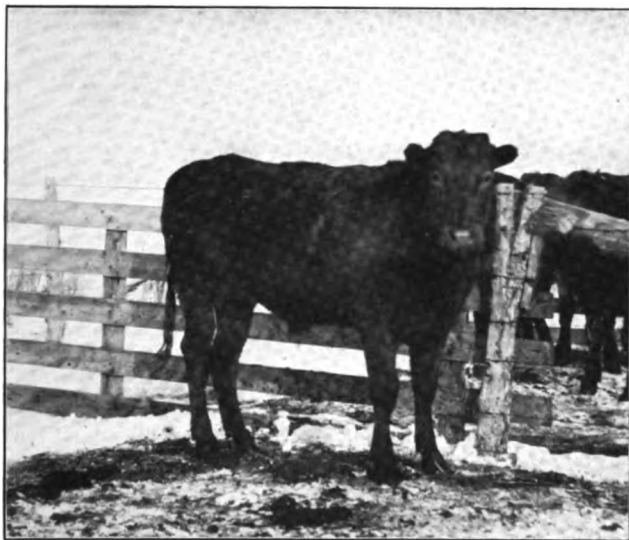


FIG. 1. A POOR TYPE OF FEEDING STEER

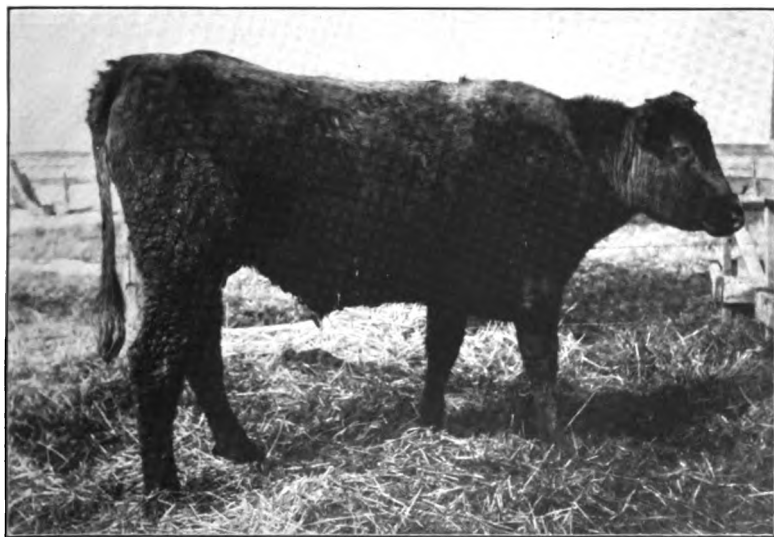


FIG. 2. A COARSE, ROUGH STEER

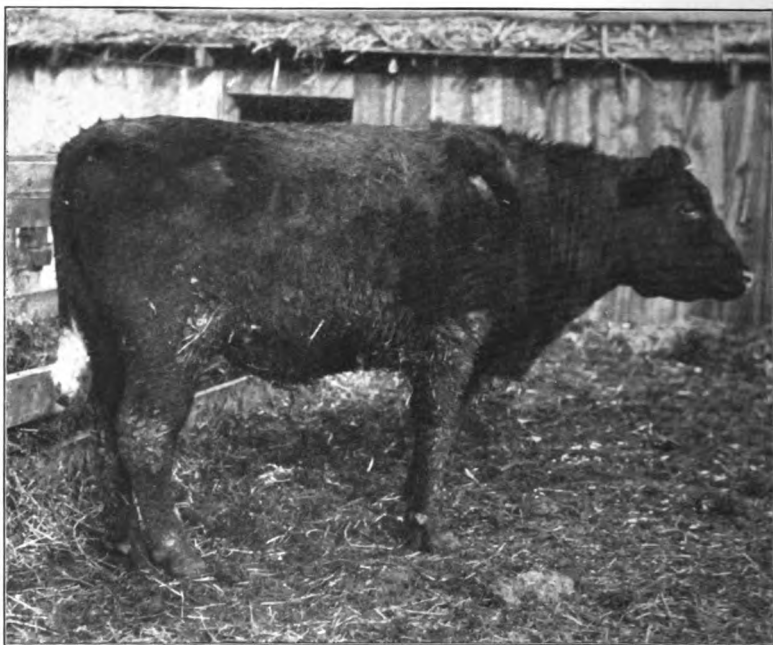


FIG. 3. THE BEST STEER IN THE CAR LOAD

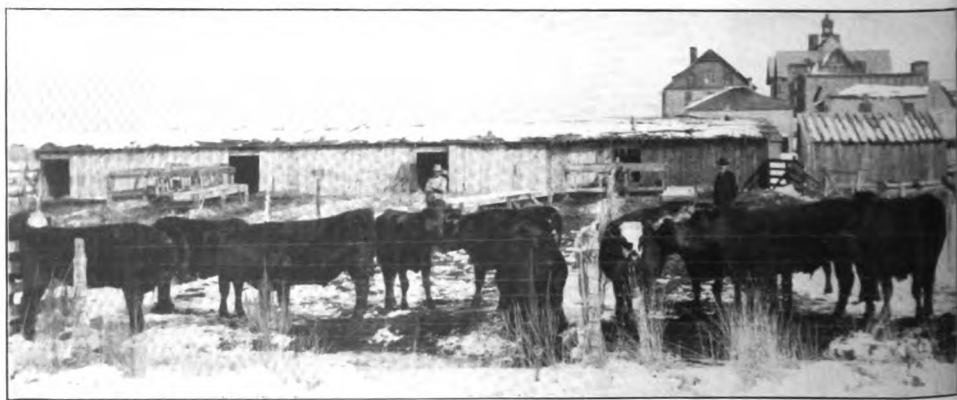


FIG. 4. THE STEERS, THE SHEDS AND THE FEEDING CORRAL

All of the lots fell off during the third period, or second part of the test period. The lots that made the best average gain during the first 65 days of feeding made the poorest gains for this period.

Considering the test period proper of 49 days; the steers fed on the mixed grain ration made the fastest gain, viz. 2.2 pounds per day per steer. The lot fed wheat is a very close second, gaining 2.19 pounds per day per steer, while those fed barley gained 1.86 pounds per day per steer, and those fed the oat ration only 1.41 pounds per steer per day, or the poorest returns of any ration.

Considering next the whole time of feeding of 86 days, the mixed grain ration produced the fastest gain with barley second, followed by wheat, while the oats ration produced the slowest gain.

For the fourth period of 25 days, after the change of the grain ration, the most rapid gains of the test were made. Lot 4 gained 3.5 pounds per steer per day, lot 3 gained 2.7 pounds per steer per day, and lots 1 and 2, 2.6 pounds per steer per day.

For the 111 days of the feeding season, lot 4 gained 2.5 pounds per steer per day, a very satisfactory gain considering the length of the feeding period, lot 3 gained 2.3 pounds per steer per day, lot 1 gained 2.1 pounds and lot 2 gained 1.7 pounds per steer per day.

On the average each steer gained 239 pounds in live weight, increasing from 1097 pounds to 1336 pounds each or 2;15 pounds per day.

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#### FOOD EATEN PER DAY AND PER ONE POUND GAIN.

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Table 2 gives the amount of food eaten, the food eaten per day, the food eaten for each pound of gain and the cost of the food. As with the weights, this table is divided into periods to show the results at different stages of the feeding.

The clover eaten per day for the first, or preliminary period, was 24.5 pounds per day per steer. For the first period on full feed the amount of clover eaten per day was 22 pounds, for the next period about 29 pounds per day. Evidently the slower gains for this period were not due to any decrease in the hay eaten. Dur-

ing the fourth period 30.3 pounds of clover were eaten per day per steer and for the whole feeding test the average was 27.5 pounds of clover per day.

As the total amount of feed eaten by the various lots is practically the same, the amount of food for each pound of gain is in inverse relation to the gains made throughout all the periods.

For the test period of 49 days, lot 1 fed on wheat and clover and lot 4 fed on mixed grain and clover required practically the same amount of food for each pound of gain, viz: 15 06 pounds. The lot fed barley required 17.78 pounds of food for one pound of gain and the lot fed oats required 23.74 pounds, the least efficient ration.

Considering the whole time of the experiment, or 111 days, lot 4 required the least food for each period of gain, viz: 12.5 pounds. Lot 3 required 14.13 pounds. Lot 1 required 14.95 pounds and lot 2 required 18.72 pounds of food for each pound of gain in live weight.

#### **COST OF THE FOOD EATEN.**

Considering next the cost of the rations: For the first period the daily cost was about 8c per day. For the test period of 49 days the cost was between 11c and 12c per day. The barley ration being the most expensive, followed by mixed grain, oats and wheat in the order named. For the whole time of feeding the average cost was 10.5c per day.

In this connection the cost of one pound of gain is the important factor. For the preliminary period the cost ranged from 3 to 5½ cents for each pound of gain. For the test period of 49 days, the cost of 1 pound of gain ranged from 5c to 8c. Lot 1, fed wheat, made the cheapest gain, viz: 5c per pound. The gain on lot 4, fed mixed grain, cost 5.22 cents per pound. For lot 3, fed barley, the cost was 6.32 cents per pound, and for lot 2, fed oats, the cost was 8 cents for each pound of gain.

Considering the whole time of feeding, or 111 days, each pound of gain cost on the average, 5.2 cents, The range was from 4.2 cents for lot 4, to 6.1 cents for lot 2.

## THE FINANCIAL RESULTS.

The steers were purchased for us by Mr. Joseph Kountz of Bozeman. Twenty-one of them cost \$40.00 each or \$840.00 and three cost \$41.00 each or \$123.00, a total for the 24 of \$963.00. The following table gives the financial results of the feeding:

TABLE III.—Financial Statement.

	LOT 1. Fed clover and Wheat.	LOT 2. Fed clover and Oats	LOT 3. Fed clover and Barley.	LOT 4. Fed clover and Mixed Grain.	Average and Totals
Number of steers.....	6	6	6	6	24
Weight at beginning.....	6675 lbs	6507 lbs	6470 lbs	6702 lbs	26354 lbs
(a) Cost of steers at 3.652c per lb....	\$ 243.77	\$ 237.64	\$ 236.28	\$ 244.85	\$ 963.00
Cost of food per lot.....	68.82	69.13	71.72	70.00	279.67
Cost of food per steer.....	11.47	11.52	11.95	11.66	11.65
Total cost of steers.....	312.59	306.77	308.00	314.85	1242.67
Weight at close of experiment.....	8075 lbs	7635 lbs	7960 lbs	8387 lbs	32057 lbs
Net gain in pounds.....	1400 lbs	1128 lbs	1490 lbs	1685 lbs	5703 lbs
Shrunk weight of steers.....	7800 lbs	7370 lbs	7685 lbs	8050 lbs	30907 lbs
Per cent shrink on full weight.....	3.4	3.47	3.45	4.25	3.58
Received for steers @ 4c a pound shrunk weight.....	\$ 312.00	\$ 294.80	\$ 307.40	\$ 322.00	\$1236.28
Received per head for each steer...	50.33	49.13	51.23	53.66	51.09
Profit or loss on feed.....	*0.57	*11.97	*0.60	†7.15	*6.39
Profit or loss on each steer.....	*0.10	*1.99	*0.10	†1.19	*0.26

(a) Note: The steers cost as stated above \$40 and \$41 each, but to place each lot on an equal basis, the lots are figured on the calculated price per pound.

\* Loss.

† Profit.

The steers cost on the average \$3.65 per 100 pounds live weight. The cost of the food for each lot ranged from \$68.82 for lot 1 to \$71.72 for lot 3. The difference in this item is but slight for all the lots. The cost of the food for each steer for 111 days ranged from \$11.47 to \$11.95. Lot 1 cost the least and lot 3 the most. The average cost for the 24 head was \$11.65 each.

After being kept without food or water for 12 hours, the steers shrank from 3.4 per cent to 4.25 per cent of their full weight. The average for the 24 head was 3.58 per cent. This is slightly less than the shrink usually estimated in buying, viz: 4 per cent. The returns per head for the steers ranged from \$49.13 each for the steers in lot 2 to \$53.66 for the steers in lot 4.

Lot 4, the steers fed the mixed grain ration, returned a profit of \$1.19 per steer after paying for the feed; the only lot that returned any profit. On lot 2, fed the ration of oats with clover, the loss was about \$2.00 on each steer, on lots 1 and 3 the loss was 10c for each steer. From a financial point of view this looks like rather a poor showing, yet the experiment is none the less valuable because of that fact. It will perhaps, better enforce the lesson that, as a rule, in finishing steers for market there has to be a wider margin of profit between the buying and selling price than was the case in this instance with Montana prices for fodders. These steers were bought, on a shrunk weight, at about 3.8 cents per pound and sold for 4 cents per pound, shrunk live weight. For profit the margin between the buying and selling price should be from  $\frac{3}{4}$ c to 1c per pound.

There is yet another compensating point to consider. The results came very close to paying market prices for the hay and grain fed, and if through his stock the farmer can get market prices for his crop on his farm, both the farm and the farmer are better off for having them so sold. At market prices he has the profits on his summer's harvest, while the manure adds much to the fertility of the land.

### WHERE THE PROFITS COME FROM.

Briefly put, the profit in the fattening of this class of steers is in the difference in the buying and selling price of the original weight of the steer and not in any profit on the increase in live weight made during the feeding period. This is illustrated in the following figures, giving the cost of the gains made for the past three years in feeding experiments at this station.

**Cost of 100 Pounds of Gain.**

	1901	1902	1903
Lot 1.....	\$4.85	\$4.00	\$5.90
Lot 2.....	\$5.16	\$4.81	\$6.13
Lot 3.....	\$5.31	\$5.80	\$4.81
Lot 4.....			\$4.17
Average.....	\$5.11	\$4.87	\$5.26

These figures are comparable only in a general way, as the steers differed in weight and quality. They show in every case, however, that each 100 pounds of increase in live weight cost close to \$5.00 on the average, a little above or below that figure. At average prices, therefore, there can be no profit on this increase in live weight; it must come from the increase in value of the original weight of the animal.

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## ILLUSTRATIONS.

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Figure 1 represents a type of undesirable steer, long legged, slab-sided, wild and restless. Only on the range could there be any profit in growing such an animal. The profit in fattening him would depend on the price at which he was purchased.

Figure 2 shows a coarse rough steer that might gain in live weight rapidly enough, but, however well fatted, would never sell at, or near, the top of the market.

Figure 3 represents the best feeding type of steer among the car load; a two year old with some width and depth of body, a good back and loin and good feeding quality.

Figure 4 shows the steers, and the sheds and yards in which they were fed. The sheds and yards were kept well bedded and it was noticed that the steers sought the shelter of the sheds nearly every night.

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## SUMMARY AND CONCLUSION.

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(1) No one feeding experiment can definitely answer the questions it aims to solve. The work must be repeated for some years and under a variety of conditions. The results here given are tentative and must wait future confirmation.

(2) According to this test a mixed grain ration proved superior to any one variety of grain. If the feeding efficiency as to rate of gain for mixed grain was placed at 100, then wheat equals 99.5 oats 84 and barley equals 84.5.

(3) From the standpoint of the food eaten for 100 pounds of gain in live weight, the wheat ration is very slightly better than the mixed grain, with oats and barley the same as on the basis of rate of gain.

(4) For the test period the wheat was also the cheapest ration, one pound of gain costing 5 cents on this ration, while the cost on the mixed grain ration was 5.2 cents, on the barley ration the cost was 6.3 cents and on the oats ration 8 cents per pound of gain.

(5) It was noticed that the cattle tired of the wheat after a couple of months feeding and a change was necessary to get the cattle to continue to eat grain. This was true of all the grains fed but not to the same extent as with the wheat.

(6) After a gradual change of the rations to mixed grain with bran the cattle ate the mixture with relish and made the most rapid gains of the winter.

(7) The experiments made at the Station for the past three years seem to show that on the average the profit to be made in fattening two to three year old steers, with Montana prices for feeding stuffs, must come from an increase in the value of the purchased weight of the steer.

(8) This fact, however, does not make less important the study of the relative values of feeding rations. In this test the difference in returns between the best and the poorest ration was \$3.52 per steer, by no means an unimportant item in feeding a bunch of steers. For instance, lot 4 gained in live weight 281 pounds worth at 4 cents per pound, \$11.24, while lot 2 gained only 188 pounds worth at 4 cents per pound \$7.52, or a difference of \$3.72: but lot 2 cost 20 cents less to feed so that the net difference was \$3.52. On a hundred steers this would mean \$352.00 as the difference in returns from feeding the two rations.



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BULLETIN No. 49, ✓

MONTANA AGRICULTURAL

# Experiment Station,

— OF THE —

**Agricultural College of Montana.**

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## Contagious Abortion in Montana

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**Bozeman, Montana, October, 1903.**

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BOZEMAN REPUBLICAN—1903



# MONTANA AGRICULTURAL Experiment Station.

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MONTANA EXPERIMENT STATION,

Bozeman, Montana.

**Notice.**—The Bulletins of the Station will be mailed free to any citizen of Montana who sends his name and address to the Station for that purpose.

# **Contagious Abortion in Montana,**

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BY H. C. GARDINER.

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# Montana Experiment Station.

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BULLETIN NO. 50.

OCTOBER, 1903.

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## Poultry Management.

F. B. LINFIELD

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### Introduction

Poultry and poultry products because of the smallness of the individual producer, and also of the product, is thought by many to be an insignificant business, yet, because of the wide and universal demand, is one of the large industries of the country. The yearly value of the product of the American hen is close to \$300,000,000, larger than any other one industry except the cow.

There is yet much room for the growth of the poultry industry in Montana, according to the statistics gathered by Mr. C. H. Edwards during the year of 1891. It would appear that about \$1,500,000 worth of poultry and poultry products from outside the state found a market in Montana—about \$5.00 for each person in the state.

To those not initiated, and to the person who handles a few fowls, no business seems so simple as that of handling poultry and yet few businesses have so many failures to record when started on a commercial scale. Much more knowledge, skill and careful management is needed, if success is to be attained, than many suppose. A person must know his flock and with patience watch them from day to day, and by proper methods of care and feeding maintain the birds in the best condition of health and vigor. To attain success with poultry a man must in a measure be a poultryman, he must have a liking for the business, and the patience that looks after every detail in the care of the birds, however small it may be.

My observation would lead me to the generalization that the organs concerned with maternity in animals are more economic producers of concentrated food products, possessing greater elasticity of

production and are capable of greater extension and development than any other construction forces in the body of the animal. This is illustrated in several directions. An old animal will not fatten as economically as a young one, but the old animal will grow a foetus as economically. The old animal again, will produce milk as economically as the young animal. The young animal retains much of the productive qualities of the maternal organs of the mother, and considering its weight, gains in live weight much faster and more economically than later in life. Poultry also illustrate this same general principle. In the production of eggs the maternal organs of the animals are concerned. A six pound hen of the laying strain will produce from 2 to 4 times her own weight in eggs in a year, and this she will do with about sixty pounds of dry matter in feed. A six pound hen on feed costing not to exceed 75c to 80c will produce from \$2.50 to \$3.00 worth of eggs at Montana prices—25c per dozen on the average.

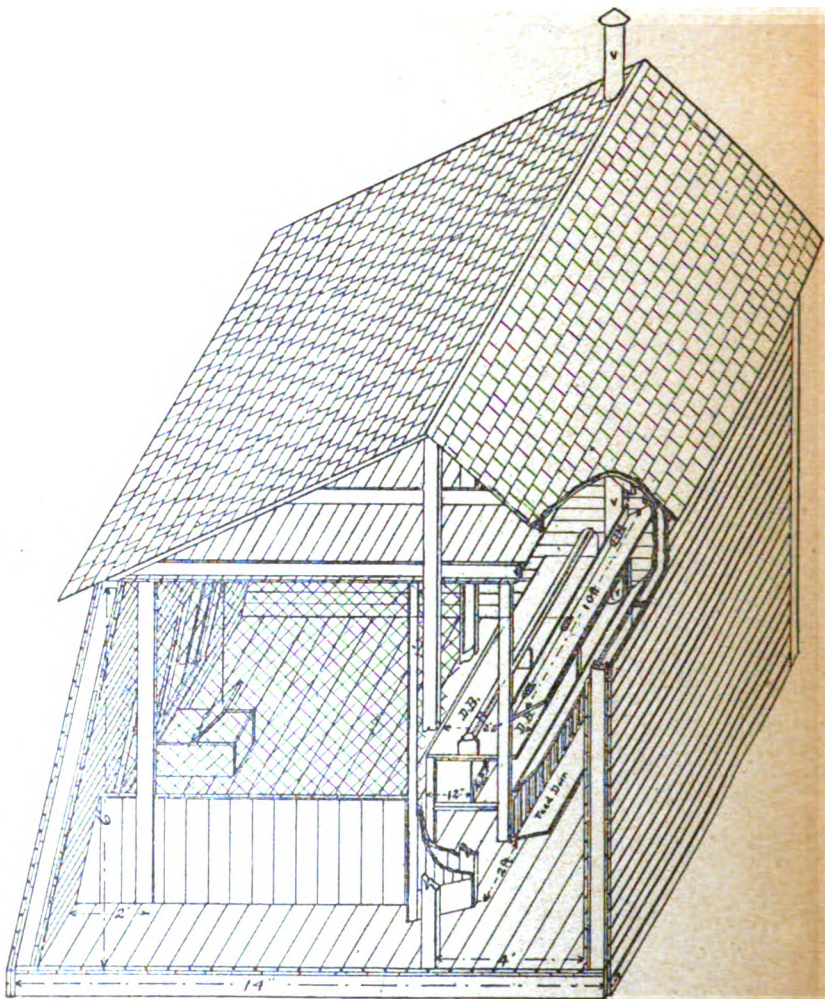
It is within comparatively recent times that attention has been paid to selecting poultry on the basis of egg records, but the result has shown that there is just as great room for increased production in this line as with milk production in the cow. Poultry, therefore, are among our most economic food producing animals. Again the prices offered in the state are such as should assure a very profitable market for the home producer.

Those who assay to obtain proficiency in the handling of poultry, however, should be students of poultry books and poultry papers. These record the experience of other men, their successes and their failures, experiences which will be of very great value to the beginner and not invaluable to the most experienced.

Success with poultry comes from so handling them as to avoid disease, rather than the ability to fight the disease when it appears important as this latter may be. It is for this reason that a few brief thoughts are added on the general treatment of fowls. Profits come from healthy fowls not from sick ones. It is very important, however, to recognize the disease when it does come, as come it may in the best managed flock, so that the loss may be reduced to a minimum and to enable us to treat the birds successfully and thus save a valuable flock for future usefulness.

## The Poultry House

In the Montana climate, probably the first consideration should



BUILDING ON MONTANA STATE FARM.

be a good house. It need not be expensive, but it should be warm,

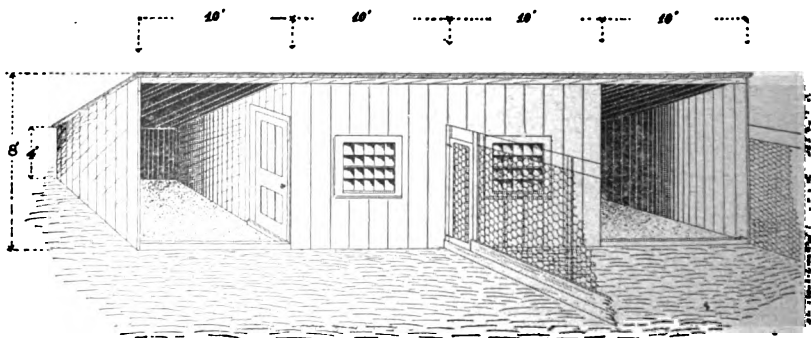
sunny and dry. Cheap lumber and building paper with plenty of window lights will give these requirements. In this connection I probably could not do better than describe the construction of the house used on the Station farm and also a house of a smaller size recommended by the Experiment Station of Utah.

FIG. 1. illustrates a model form of poultry building, and is with the exception of some slight details of the same construction as our main building. This house is 14 feet wide, pens 12 feet long with walls, roof, floor and windows constructed as previously described by the wall double boarded inside and out with tar paper between. The floor also double, and on the roof tar paper beneath the shingles. A four foot passageway runs throughout the rear. Access to the pens is through doors two feet wide, which open inward against a partition between the pens. This partition is matched stuff for 2 feet and then wire netting up to the ceiling. The arrangements of the roosts (R), the drop boards (D. B.), the nest boxes (N. B.) and the feed board are very simple. The fowls are fed their soft feed through the slatted front of the pen upon the hinged feed door, which when not in use, is hooked in a perpendicular position. These slats are three inches apart and fourteen inches high. Immediately above upon a platform 20 inches wide, the nest boxes are placed facing the passageway. Eggs are gathered from them by opening the hinged door in the passageway which extends in front of the platform. Nests are best made of  $\frac{1}{2}$  inch lumber, boxes 12x12x14 inches dimension. Above the nest boxes is another platform 22 inches wide which catches the droppings from the roosts. This drop board (D. B.) extends about  $1\frac{1}{2}$  inches into the passageway so that in cleaning the edge a pail may catch under it. The roosts are placed 6 inches above the drop boards and are  $2 \times 3\frac{1}{2}$  inches with corners rounded off and the flat side up. (V) Ventilator is placed in the corner of the pen close to the passageway, and the damper is operated therefrom. The exit through the floor is surrounded by a box as shown. This is to prevent litter from falling through. The front wall is inclined inward two feet at the top in order to take greater advantage of the sunlight, and the building is sealed with matched flooring upon the lower side of the collar beam. Where it is intended to keep only 40 or 50 birds, a saving of space may be affected by running the

passageway through the center of the building from front to rear, making two pens and arranging nest boxes, etc., on either side of the passageway, with the door on the north side and the ventilators on either side

## Ventilation.

Proper ventilation is an important factor in the management of the poultry house, and the object should be to remove the foul air and retain the warmer and purer air without causing a draft. Our method of securing this result is simple. An ordinary stove-pipe with damper extends from a hood on the roof to within six inches of the floor. The lighter and warmer air near the roof of the building warms the metal pipe which is a good conductor, which in turn warms the air inside causing it to rise slowly. As a result, the air flows into the pipe from the opening near the floor, this gradually removes the air in the immediate vicinity of the fowl. We have found this method an admirable one in our practice, performing the work excellently.



HOUSE ON UTAH STATION FARM

"I give here a sketch of a poultry house that will answer most purposes. It will be suitable for the farm and also for the town lot. It can be extended to any length desired, or it may be cut in two where only a small number of fowls are to be kept. The dimensions given are for a house that will accomodate about fifty of the smaller breeds of fowls and about forty of the larger.

### **Dimensions.**

"It is forty feet long and 10 feet wide, divided into two pens, each ten by twenty feet, ten feet of the closed part being for the roosting and laying apartment and ten feet open scratching shed. It is eight feet high at the front and four feet at the back. The outside yards should be about 20x100 feet each. There is no hallway, but there is a door entering from the open shed into the closed part. The partition between the two outside pens may be of wire netting but there should be about two feet of boards at the bottom to prevent the fowls fighting through the wire.

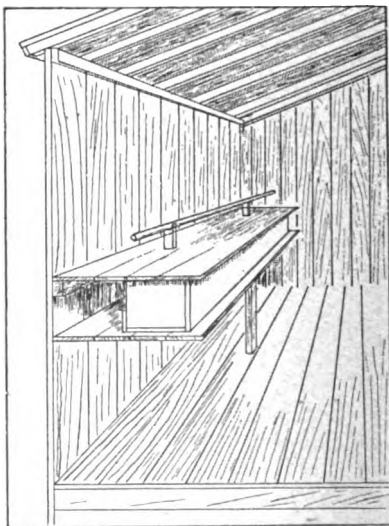
### **Materials**

"The sills should be about 4x6. For framework and rafters use 2x4 stuff. On outside of studs nail good common lumber close together. On top of this tarred paper; then on top of this put on tongued and grooved lumber up and down. For the roof use common sheeting laid close together. On top of this place tarred paper, then shingles. Instead of shingles Neponsit Red Rope paper may be used. The door opening into the scratching shed should fit tightly and if necessary a storm door should be put on in winter to shut out cold and draught. The window should open into each of the closed pens. This should be about 24x24 inches, and it should be double in winter. It should be low enough down so that the sun in winter entering the the window will fall on the floor. The end walls of the scratching shed need not be double boarded and papered, but should be airtight.

"In the colder portions of the state it may be necessary to use another thickness of boards and paper in the closed pens. In that case another layer of paper can be put on the studs and tongued and grooved boards on top of that. But probably a better arrangement would be to nail sheeting on the studs and put Neponset Red Rope roofing on top of that. That makes a good lining. All lumber in the inside of the building should be planed. This makes it easier to keep the house free from vermin. Instead of lumber the walls of the closed pen may be made of brick with adobe lining. Some claim that this will be warmer and drier.

## Nest Box

"One of the important things in the poultry house is the nest. To prevent egg-eating the box should be dark and shallow. The cut shows a good plan. It shows a roosting platform with a row of nests underneath. This plan is recommended by the *Reliable Poultry Journal*. If intended for Leghorns, or medium sized hens, nests 12x12 inches and 7 or 8 inches high will be about right. If for Brahmas or Cochins they should be about 15x15 and 10 inches high. Have some chaff or other good material in the bottom of the box so that there will be less danger of the eggs breaking, as a broken egg in the nest is al-



THE NEST BOX

most a sure way of teaching the hens to eat eggs. The bottom board of the nest shown in the illustration should be hinged to the wall of the poultry house so as to open upward. The upright which holds the bottom board in position is also on a hinge so it can be kicked from under the board to allow cleaning. The top board or roosting platform should be built on an incline and also hinged to the wall so it can be

raised to get at the eggs. The roosting pole should be about six inches above the platform and may be 1x3 inches, the hens sitting on the wide surface.

### **Storm Door**

"For stormy weather there should be provided a storm door for the open shed. This may be made of oiled-canvass tacked on to a light frame and should be hinged at the top so that it can be hooked up to the ceiling when not needed."

### **Size of House and Pens**

The size of poultry house usually recommended is one that will give about 6 to 8 square feet of floor space to each bird. Thus, a pen 10x12 feet will accomodate 15 to 20 birds.

The modern practice is not to allow the fowls the run of the farm except perhaps for a month or two in the fall after the crop is off, but to confine them in yards near the house. These yards or runs should afford 50 to 100 square feet of space for each bird. Part of the run should be planted to clover and grass. In part sunflowers may be planted for summer shade and fall feed, and part may be cultivated for a succession of green crops during the summer.

### **The Stock to Select**

For satisfactory results, good birds are needed, and here as with other classes of livestock, pure breds and not cross-breds or scrubs are to be preferred, particularly on the side of the male. Again, get a good strain of the breed selected, a strain noted as large egg producers. Poultrymen are now gathering such data and breeding for a record.

The profit with poultry will in a large measure be influenced by the time the eggs are produced. During the late fall and winter months, fresh eggs command a fancy price. Young stock, the early hatched pullet, is the bird that under proper care will produce eggs at this season. Not alone is the young bird an early layer, but they also produce the largest number of eggs per year. As a rule the first two years are the profitable egg-producing years of the fowl's life. These birds should not be kept over the third winter except perhaps for the

purpose of producing eggs for hatching, if an extra fowl. This larger return from the young fowl many people seem to forget, yet it is a very important fact in poultry profits.

### **Comfortable Quarters**

In the proper feeding and proper care of fowls is where perhaps most people fail. Fowls as a rule will not produce eggs if subjected to the continuous cold weather of winter. They must therefore be comfortably housed. There is danger here, however. During the day with the sun shining on the building, the house warms up and the warm air takes up much moisture. During the night, on the other hand the house cools off very much and may chill the birds. The cold air, moreover, not being able to hold as much moisture as the warm air, the moisture may condense in the house, making it damp. These extremes in temperature and also the consequent dampness frequently give rise to colds and may develop into roup of some form.

These extremes of temperature and the dampness may in a measure be avoided by thoroughly ventilating the house during the day, being careful, however, to avoid draughts, and then closing up the house at nights. If in addition to this a little heat is used in the house at night the result will be still better. It will not need much heat, just enough to prevent the house getting very cold, thus avoiding extremes.

This of course is artificial treatment but so is the production of eggs during the cold winter weather. To get the winter egg we must keep the fowls comfortable and healthy. The easiest and safest method to attain this may be by a little artificial heat during the winter. In a small house a small stove is the only practical method of heating and some form of the hot blast stove in which the draught can be thoroughly controlled and a small fire kept going for several hours. For a large poultry house, some form of small water heater is preferable as the heat may be more easily distributed over the building and more easily regulated.

The central thoughts are (1) that to produce eggs in winter a comfortable temperature for the fowls must be maintained and too great cold avoided; (2) that a fairly uniform temperature must be

maintained; (3) dampness must be avoided. There are probably other ways than those suggested to attain those objects.

## **Feeding Poultry**

The matter of feeding while important is perhaps not as difficult to properly provide for as the matter of comfort and health. The weight of experience seems to show that a proper combination of hard feed, soft feed, green feed, meat scraps and grit give most satisfactory results.

In the morning give a warm mash, composed of bran and shorts and some ground grain. This should be mixed with water and seasoned slightly with salt and pepper. This mash may with advantage be wet and mixed with warm skim milk instead of water. The skim milk is valuable as a poultry food and can in a measure take the place of meat scraps or other animal food. Do not give a full feed of this but after it is eaten up clean, scatter some grain in the litter on the floor, for the hens to scratch around and gather up. The grain should vary from wheat and oats to peas or corn, if available, to give variety. About the middle of the afternoon or a little later give a feed of wheat also scattered in the litter on the floor, all that the birds will eat up before roosting time. This method of feeding forces the fowls to keep busy and gives them exercise which is needed for healthfulness when confined in pens. Give cut bones and meat scraps three times a week. In the winter keep a little green feed available for the fowls all the time, a head of cabbage hung up in the pen and at other times a mangle or sugar beet and again a little lucern or clover leaves will add variety. In the summer if the runs are large, part of them may be seeded to clover or alfalfa. or a little rye may be sown as a variety.

Fowls need grit to grind their food. Having no teeth the food must be ground in a special organ, the gizzard. Again, grit is needed to give material for the egg shell.

Bones provide a certain amount of animal food and also grit for shell material. Bones and meat scraps are usually inexpensive, but take some work and trouble to prepare as they have to be ground. Their place may be taken by oyster shells, ground bone and dried blood. The first cost of these is greater but they require little or no prepar-

ation before feeding. In the summer when the fowls have the use of a large run and especially if part of it is cultivated, less grit and animal food have to be provided, and if later in the season, for a month or so, they have the run of the fields they will be able to gather sufficient of both.

Fresh water should also be available for the fowls at all times.

Cleanliness and freedom from vermin are essential points in poultry profits. The poultry house should be whitewashed, using freely slaked lime, at least twice a year, the roosts should be frequently cleaned off and the litter cleaned out and replaced once a month or oftener. The birds will keep their bodies free of vermin if they have ready access to a dust bath. The roosts and nests should have an occasional wash of coal-oil to keep those pests in check.

# Poultry Diseases Common in Montana.

BY H. C. GARDINER.

## Introduction

Diseases in poultry are in general not effectively treated in the diseased individual, because of the fact that the trouble and time necessary for treatment more than equal the value of the individual bird. On the other hand an understanding of the different diseases with their predisposing causes is very essential in order to avoid loss and keep the flock free from disease.

In general it may be said that fowls properly fed, properly housed, and intelligently handled will keep in a vigorous healthy condition. In our experience at the Station the slight occasional loss of probably seven or eight birds in four years has been directly due to some error or oversight in care or feeding.

Diseases may be said in general to result from two conditions, one in which unfavorable surroundings, feed, etc., produce the conditions and on the other hand direct infection from some infectious or contagious disease. It is probably wise to point out at this time that the second source is most active when the fowls are in low condition as a result of improper feed and care.

## Roup

Roup is undoubtedly the cause of more fatalities in the mature flocks of the North-western states than any other disease. It is generally prevalent in Montana and in certain localities is causing severe loss during the winter months.

During the past four years a thorough investigation of this disease has been carried out by the Bacteriological department at the Ontario

Agricultural College and the results of these investigations published in Bulletin 125 of that Station. The following notes on the disease are taken from that source.

The disease is infectious and due to a bacillus (*B. cacosmus*). It is prevalent in fowls kept in filthy, damp, draughty and poorly ventilated quarters. Vigorous stock in good surroundings prove quite resistant to the disease. Young fowls and those of the more delicate breeds are much predisposed to the disease.

### Symptoms

The earliest symptoms is a putrid catarrh of the nostrils, followed by a dumpish condition during the earlier stages; and in the less severe forms of the disease the fowl retains its appetite. In some instances the face becomes swollen, birds manifest loss of appetite, becoming emaciated, and lie down and die in a few days. During the latter stages of this disease, diarrhoea with offensive yellow or green discharges hasten the fatal termination of this disease. To quote Bulletin No. 125, Ontario Agricultural College. "In the first stages of roup the birds often cough or sneeze and the breathing is noisy, caused by the partial closing of the air-passages which become blocked with the discharge from the nostrils. When the air passages become entirely closed by the discharged products, the fowl has to open its beak in order to breath. Sometimes a yellowish cheese-like mass forms in the nostrils, if this mass is removed, an uneven bleeding surface is left, which form a new cheesy mass in from 24 to 48 hours."

These cheesy masses sometimes grow in the eyes and in the ducts between the eye and nostril and sometimes form in small tumors under the skin of the face. "The secretion from the eyes is similiar to that described as coming from the nostrils, i.e., at first a clear liquid, then changing to a putrid grey and offensive discharge. If the secretion is retained in the eye socket, it undergoes a change, becoming a yellowish, solid, cheesy mass of the same appearance as the nasal tumor. This cheesy mass either forces the eye out of its socket or the inflammation entirely destroys it.

Combined with the symptoms of roup above described, there are often patches of a greyish, yellow exudation firmly adherent to

the mouth, throat, etc. These patches are called false membranes. At one or several places in the mouth and throat, these yellowish, smooth or uneven membranes appear, and either remain small and disappear after a few days, or grow thicker, spread, and become firmly attached to the mucous membrane, and if they (the false membranes) are removed, an uneven, bleeding surface is exposed.

When the throat is blocked by these false membranes, the animal's breathing becomes abnormal, and the air passing through the throat produces loud noises. Gradually the visible mucous membrane and the comb turn blue, and the fowl generally dies from suffocation.

### **Treatment**

Care taken to avoid infection as outlined in the causes, which predispose toward this disease, isolation of infected birds and disinfection of poultry houses and runs immediately adjacent, with a 3 per cent. creolin solution constitute the treatment, under average circumstances. If particularly desired to save some valuable individual, immersing the head in a 1 to 2 per cent. permanganate of potash solution is a method of treatment giving valuable results. "Fowls are treated in the following manner: The nostrils are pressed together between thumb and forefinger in the direction of the beak several times. Pressure should also be applied between the nostrils and eyes in an upward direction. This massage helps to loosen the discharge in the nostrils and eyes. The bird's head is then plunged in a potassium permanganate solution for 20 or 30 seconds, in fact the head may be kept under the solution as long as the bird can tolerate it. The treatment should be given twice a day until all symptoms have disappeared."

In conclusion our authority says: "The most effective preventative for roup is to keep fowls in good, sanitary condition in dry, roomy yards, and dry, clean, airy houses which are free from draughts and can easily be cleaned and disinfected."

### **Catarrh**

Catarrh in poultry closely resembles the common "cold in the head" of man. It is accompanied by sneezing, difficult breathing,

watery discharge of nostrils, in later stages becoming thick and glutinous.

The causes producing this disease are lack of ventilation of houses, draughts, dampness, cold winds, exposure, improper care and feeding. The prevention consists in the removal of such conditions, and when birds become affected, Douglas mixture in the drinking water acts as a splendid tonic. In addition the following powder may be given in the food: Gentian, 1 ounce; ginger, 1 ounce; capsicum,  $\frac{1}{2}$  ounce; iron sulphate,  $\frac{1}{2}$  ounce; hyposulphate of soda,  $\frac{1}{4}$  ounce; a teaspoonfull to 15 fowls being about the right proportion. Douglas mixture is a splendid tonic to give during the fall, winter and spring months and we have found with its occasional use, sickness is a very rare occurrence.

Douglas mixture consists of: Sulphuric Acid, 1 ounce; iron sulphate, 3 ounce; water, 2 gallons; a teaspoonful to a pint of drinking water is sufficient. We have made it a practice to give it once a week in the drinking water, and where there were any signs of disease used it in drinking water daily.

### Gapes

The gape worm is causing loss among flocks in some sections of Montana and with the growth of poultry raising will give serious trouble in the future unless steps are taken to suppress this parasite.

It is a small reddish colored worm which infests the trachea (windpipe) of young chickens and gets its nourishment by sucking blood from the wall of the windpipe, where it causes much irritation, and may occasion inflammation and suffocation. The male worm is about 1.5th of an inch in length and the female  $\frac{1}{2}$  inch. They are usually found attached in pairs to the windpipe. This infection occurs as a result of swallowing embryo worms or eggs in drinking water or in the food. A single infection is however all that is necessary as the worms reproduce in the body of their host. This practice secures most of its victims among the smaller and weaker chickens as they most easily become exhausted and suffocated.

### Symptoms

The disease chiefly affects chicks from 1 to 4 weeks old and may be detected by the dumpish condition of the birds, by gaping frequent-

ly with the head extended. Later a cough is noticed and a wheezing sound accompanies the breath, with gaping at frequent intervals. While coughing the chicks frequently dispel the parasites, which may be detected in the mucous which accompanies the coughing. As the disease advances the chicks become emaciated and weak, wings hang down, gaping and shaking of head are frequent, and at last death from suffocation and exhaustion intervenes. The stronger birds and those infested with a few worms, only evidence a slight inconvenience and soon shake off the effects of the disease.

### **Treatment**

Individual cases may be relieved by removing the worms from the windpipe with the end of a feather or a loop of horse hair, and excellent results may be obtained by dropping one or two drops of salicylate of soda in the wind pipe.

General treatment consists in the prevention of the spread of infection, by isolating the affected birds, frequent disinfection of their yards with 5 per cent solution of crude carbolic acid, disinfection of drinking and feeding troughs with boiling water, and exerting every precaution to prevent the contaminating of their food or drink. The bodies of dead birds should be burned and where possible healthy birds should be changed to new runs until the old runs were thoroughly disinfected.

### **Lice**

The large grey louse (*Liperiris caponis*), the red mite (*Dermaceys-ses gallinae*), the bird flea, and the mite (*Sarcoptes muteces*) causing scaly legs, are the external pests causing the bulk of the trouble arising from the insect pests.

Cleanliness is the starting point of success in combatting these pests, and houses and fixtures of simple construction, affording few cracks aid materially in preventing attacks, as they do not afford the protection necessary for the lice.

In keeping buildings free from lice, kerosene must be used freely on roosts, nest boxes and other fixtures, accumulations of filth are to be avoided in every direction, and all surfaces on the inside of the building should receive a coating of white-wash containing carbolic acid at

least twice a year. The efficiency of this white-wash is greatly increased if applied with spray. Litter on the floor of pens and in the nest boxes should be renewed frequently and insect powder scattered in the nests. Kerosene emulsion is valuable particularly for the flees and mites and is best applied with a spray pump and made as follows: Kerosene, 1 gallons; water, 1 gallon, soap,  $\frac{1}{2}$  pound. Dissolve the soap in the water by boiling, and while hot turn in the kerosene and churn briskly for 5 minutes. This solution is sufficient for about 15 gallons of spray solution. Six ounces of crude carbolic acid to the gallon of water (hot) also makes a very good solution to use as a wash for roosts, nest boxes or floors, when cleaning out.

The largest number of deaths from these pests occurs from the large grey louse which attacks young chicks. These lice are found on almost all chicks which have been hatched under hens and annually kill thousands of young chicks. It is a good practice to grease lightly the back of the head and under the wings on all young chicks which are hen hatched, the lice confining themselves almost entirely to those parts. Common lard serves the purpose but we have used carbolated vaseline and find it preferable.

The red mite is combated more effectually with kerosene applied to the hiding places, by the use of insect powder on the fowls and by providing opportunities for dusting

The mite causing scaly leg is a particularly annoying pest and very prevalent. It barrows under the scales on the legs and by its irritation causes an exudation of which the enlarged scaly portion is formed. The heavier breeds of fowl are most affected by this pest, the Mediterranean classes apparently resisting its attack to a marked extent.

In order to avoid the spread of this disease it is well to isolate affected birds when treating them in order to prevent the infection of the rest of the flock. In order to reach the parasite it is necessary to soak off the scaly crust with warm soapy water and then carefully remove to avoid bleeding. The legs should then be moistened daily for three or four days with balsam of Peru or 10 per cent. creolin ointment.

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MONTANA

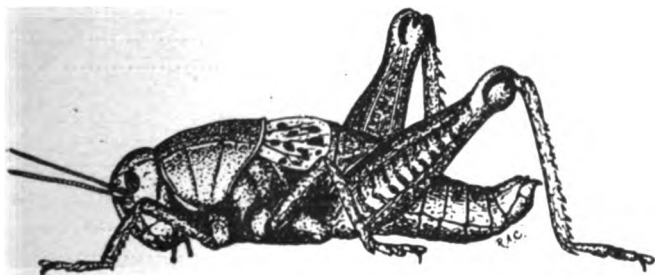
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—OF—

THE AGRICULTURAL COLLEGE OF MONTANA.

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**First Annual Report of the  
State Entomologist of Montana.**

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**BOZEMAN, MONTANA, DECEMBER, 1903.**

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**Bozeman, Mont.  
The Avant Courier Publishing Co.  
1904.**

1936

# Montana Agricultural Experiment Station, Bozeman, Montana.

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**Notice.**—The Bulletins of the Station will be mailed free to  
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THE COMMON TOAD  
(See Article in this Bulletin)

# Montana Experiment Station.

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**BULLETIN 51.**

**DECEMBER, 1903.**

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## INTRODUCTION.

This first Report of the State Entomologist of Montana contains an account of a few of the most important insect pests of Montana and in addition, a fairly complete, though condensed, manual of insect pests. This manual is intended to put in easily accessible form the most important information regarding a large number of insects now in the state or liable to be introduced.

Considering the great importance of the codling moth, the reader will perhaps expect to find an account of it in this report. However, such an account is omitted for two reasons, first, a report on this pest was issued from the Experiment Station a few months ago, copies of which are still available for distribution, and, second, it is intended to conduct further investigations on this pest during the coming summer (1904) and we shall desire to publish those results one year from now. In view of the fact that the codling moth will for years to come be the most important insect pest with which Montana apple growers will have to contend, it is our intention to make the next report upon the subject the most complete and practical that has yet been issued from this Station.

In view of the great economic importance of grasshoppers and because of the unusual demand for information concerning them, we have given them prominence in this report.

We renew our statement of willingness to answer inquiry regarding insect pests. Such requests for information should always be accompanied by specimens of the insects that are doing the damage and a statement of the facts necessary for our information in making recommendations.

Every vegetable product of the soil is subject to the attack of insect life and every crop that is grown by men is more or less in-

jured by insect pests. These injuries may be so conspicuous as to force themselves upon our notice or they may be so hidden and insidious as to escape detection except by the most observant. The farmer may suffer heavy financial loss, or because of the higher price which comes as a result of a shortness in the crop, he may be only slightly affected. In the latter case the general public become the sufferers, but in all cases, losses through depredations of insects come out of the coffers of man, if not out of his daily bread.

Considering the great agricultural possibilities of this state, together with the fact that, incidental to commercial practices, injurious insects new to this region are constantly liable to introduction, it is very important that every possible means be employed to prevent the introduction and spread of pests of all horticultural and agricultural plants.

All rational means of defense against injuries from animals of this class are based on a more or less intimate knowledge of the life history and habits of the insects. It is apparent, therefore, that as a defensive measure the acquiring of a knowledge of life histories of the insect destroyers of our crops is of great practical value and must always precede quarantine and medical work.

Again, in order that investigations may be safeguarded against danger of becoming narrow and losing their practical setting, it is obviously necessary that they be conducted not only in the entomologist's office or in one locality, but in the field and throughout the state.

Realizing the truth of these statements the Entomological Department of the Experiment Station is centralizing its efforts on the accumulation of information regarding species of insects that are now or may become injurious and, obedient to the Act of the Eighth Legislative Assembly, whereby the office of State Entomologist was created, is making its observations and conducting its experiments in all parts of the state.

## THE BUD MOTH.

*Tmetocera ocellana* Schrif.

The bud moth was first discovered in this country in 1841 in Massachusetts and was at that time doing considerable damage. In 1869 it was pronounced the most injurious enemy of the apple tree, next to the canker-worm, in the state of Massachusetts. Since that time it has been spreading westward and has at times been very destructive, notably in 1891 throughout Massachusetts, New York and Canada and again in Michigan in 1892. It now occurs throughout Northern United States from the Atlantic to the Pacific ocean but is much more thoroughly distributed in the east than in the west. It has been found as far south as Washington, D. C.

For fully fifty years previous to the time the insect was first detected in Massachusetts it was a well known and destructive species in Europe. There can be little doubt that it was introduced into America from Europe on young trees, intended for planting.

### OCCURRENCE IN MONTANA.

While engaged in certain investigations concerning the codling moth in Missoula in the spring of 1902 the writer's attention was called to trees in the home orchards on Front street, Missoula, the foliage of which showed distinct signs of injury by insects. On examination it was found that the injury was caused by the bud moth. The vernal form of the larva was doing rather serious damage on many trees. The buds, both leaf and flower, were severely injured and a large proportion of the expanding clusters of leaves were tied together, each containing one of more nearly full-grown larvae which were feeding voraciously. Beside occurring throughout Missoula and in the orchards just outside of the city, the insect was also gaining a foothold for a considerable distance up the valley of the Bitter Root river.

### IMPORTANCE OF THE PEST.

To just what extent this insect will be destructive in Montana's climate, if it becomes generally distributed, cannot be foretold. Ex-

perience of other localities has distinctly shown that its injuries will be more severe some years than others. For the present, at least, Montana fruitgrowers should look upon it as a pest of first-class importance. They should inform themselves concerning the habits and appearance of the insect in all its stages and should be on the lookout for it in the orchard.

Spraying does not appear to be effective in killing the larvae. Should the moth be admitted to the nurseries of the state it would be very unfortunate not only for the nursery men but also for the persons who purchase trees from them.

### NATURAL HISTORY AND HABITS.

The larva or so-called worm spends the winter in a temporary cocoon or hibernaculum on the trees. These hibernacula are remarkable objects in that they so closely resemble the bark and the felty surface of the young twigs as to be very difficult of detection even by a trained eye. They are closely secreted in crevices around the buds or in the depressed scars that mark the spots where leaves were attached. They are about one-sixteenth of an inch across and though made principally of the silken secretion that is produced from the silk organs of the mouth of the caterpillar, they contain enough of the surface parts of the surrounding bark to make them very inconspicuous.

Besides occurring on the twigs as has been described by various authors, the writer has found them also under the scales of bark in association with the hibernating larvae of the codling moth.

In the spring of the year at about the time the buds are swelling the larvae, which are dark brown with black heads, emerge from their winter quarters and crawl to the buds. Observation is lacking in Montana as to the precise time, compared to the opening of the buds, that they arrive. It is probable, however, that in this respect the habits would not vary much between here and other climates, for the same conditions of weather revive both insect and plant life. Without much doubt, while a few larvae arrive early enough to make it necessary for them to bore into unexpanded buds in order to get food, the majority of them reach the buds after they have begun to open. In both cases, alike, the larvae, which at this time

are less than a quarter of an inch in length, go at once to the tender, inner part of the bud, where they feed on the tender parts and do great injury, often destroying the terminal growing portion of the twig. If the bud be a fruit bud it likewise is destroyed, thereby preventing the possibility of the production of fruit.

The destruction of the terminal bud prevents the further elongation of the twig and at the same time causes some lateral bud to grow into a principal stem. While in some cases such an unnatural growth is not a disadvantage, in many cases the result is a very undesirable shape of tree. This is particularly true of young trees in the nursery row.

The larva soon makes use of one of the more advanced leaves in the construction of a tubular retreat, which constitutes its home and from which it emerges from time to time to feed. In feeding, it draws in other leaves and fastens them together into a sort of nest which is very characteristic of the species. Some of the leaves become detached, but being bound to the other leaves fail to drop to the ground, thereby making the nest all the more conspicuous, because of the brown leaves among the green. A badly infested tree therefore has a decidedly unnatural appearance.

The larvae continue to feed in these nests until they reach full growth, when they construct cocoons in which the remarkable change from the larva to the pupa and from the pupa to the moth is to take place. The full grown larva is a half inch in length, nearly naked and of a brown color with glossy black head and shield just behind the head. See plate I, (figure 7).

The cocoon is constructed, in many cases, in the tubular retreat occupied by the larva. The walls are thickened and the ends closed up, thereby preventing the entrance of parasites, while the moth lies in the defenseless pupa stage. Other cocoons are made at any convenient place. Sometimes they occur in a fold of an otherwise uninjured leaf.

In due time, or about two weeks from the time the larva changed to a pupa, the moth appears. The pupa works its way out of the end of the cocoon, aided by the hook on its back, and the anterior end splits, thus setting free the moth, which crawls out, expands and dries its wings and flies away. In Missoula the moths

appear from about the first to the twenty-fifth of July.

The moths are most active during the night, remaining quiet during the day on the bark of the tree, which they closely mimic. They are also found to some extent during the day in the foliage. The cage erected in Missoula in the spring of 1902 for the purpose of facilitating the study of the habits of the codling moth, has afforded us also an opportunity for the close study of the bud moth. The bud moth was very abundant in this cage in 1903 and destroyed practically all the fruit buds, interfering seriously with our investigations of the codling moth. When disturbed or frightened the moths often flew directly away from the tree and coming in contact with wire netting clung quietly to it for a few moments. In a few moments, however, they flew back to the tree. It is plain that they did not feel safe on the netting and they would not have been safe were it not for the fact that no birds could reach them on the inside of the cage. In flying at such times the moth pursues an irregular zig-zag course and comes immediately at rest on lighting.

It is worthy of special notice that there is a close resemblance between adults of the bud moth and of the codling moth. An experienced person need have no difficulty in distinguishing between the two if he has before him fresh specimens, but when the scales of the wings are rubbed off as they often are in specimens captured in the orchard, separating the two at sight is not so easily done. When once placed on his guard, however, a trained observer is not liable to make a mistake. On the other hand there are many less important small moths in the orchard which the untrained observer or the person who has paid little attention to insect life may mistake for both of these orchard pests.

In a few days after emerging the moth begins to deposit eggs. We had no difficulty in finding quantities of them in the cage at Missoula and they were invariably on the smooth upper surface of the leaves. Other writers have stated that the eggs are laid singly or in clusters and on page 61 of Prof. Slingerland's bulletin on this insect (No. 107, Corn. Univ. Agric. Exp. Sta. 1896), is given a figure of a group of these eggs numbering about six, but our observation shows plainly that in Montana the eggs are laid singly. We have never found

more than two together. A single egg is shown at plate I (figure 1). They are usually oval in outline, some being circular or nearly so, and they measure slightly over one mm. in length, including the flat outer rim by which they are attached to the leaf. They are translucent and almost colorless at first, but as the embryo develops the black head and thoracic shield of the larva show through and the outline of the curled larva may be distinctly seen. The egg shell reflects the prismatic colors, both before and after the larva emerges.

We have above called attention to the close resemblance between the adult of the bud moth and that of the codling moth. It is even more difficult to distinguish between the eggs of the two species. In size, shape and general appearance, they are very similar. They are laid in precisely the same position on the foliage and are deposited at the same time. They both reflect light and show iridescence alike, and both are translucent. I know of no way to distinguish between the two except by the difference in the character of the surface of the shell of the egg.

The hatching of the egg takes place in from six to ten days after being laid, and, issuing from the egg, the larva makes a hole through the edge of the central portion and crawls forth. This caterpillar is greenish in color, very small and delicate and it at once sets about making a place of retreat and protection. Passing to the under side of the leaf it constructs a very small silken tube near the mid rib and usually towards the base of the leaf. The larva feeds from the epidermis and middle layers of cells leaving the opposite epidermis unbroken. The castings of the larva are built into the tube giving it a black color. The portion of the leaf from which the larva feeds is covered with silken threads laid down by the larva and whenever possible a near-by leaf is drawn up and fastened to the first leaf by the silken threads. Thus one often finds two leaves stuck together, and, in pulling them apart, finds the little black tube of this insect. The larva will not be seen unless forced to crawl out.

In selecting a place in which to construct a home the larva searches for two leaves that are near enough together to be easily brought in contact.

In the manner here indicated the larvae continues to feed until some time in September, when, apparently prompted by instinct they

crawl to the twigs, spin the temporary cocoons which they occupy during the winter months, and from which they issue in the spring and pass to the buds as previously stated.

### THE KINDS OF TREES THE BUD MOTH ATTACKS.

While this insect is best known as an apple pest, it feeds also on pear, plum, quince, peach and cherry trees and on blackberry bushes, in all cases feeding on the buds.

### MEANS OF DISTRIBUTION.

The manner of hibernation of the insect makes it very easy for it to be distributed on nursery stock, and this is doubtless the way in which it has become so widely distributed. It may be readily distributed on scions.

The moths are capable of flying and doubtless go from tree to tree and from orchard to orchard but they can only spread slowly in this way.

### NATURAL ENEMIES.

It is very probable that many of these insects fall a prey to the birds that frequent the orchards. In fact it is reported that birds sometimes eat the moths. There can be little doubt that the Oregon chickadee, that is so common in the orchards searching on the trees for food, does much good in destroying these insects. Various other birds probably eat them in Montana.

It was very noticeable that the tree which had been inclosed in the cage in Missoula for one year was much more seriously affected by this insect. Birds had, of course, been excluded.

A number of parasites have been taken from the bud moth in the United States and in Europe but just how much good they do cannot be stated. I have reared an undetermined species from specimens of this pest brought from Missoula to Bozeman for study.

### METHOD OF PREVENTING ITS RAVAGES.

In the East this insect is said to be a very difficult one to control. Just why this is so has never been fully explained, and as yet we lack a sufficient knowledge of the habits to enable us

to state definitely the cause of the failure of remedial treatment, but there is some reason to believe that in Montana a large majority of the larvae arrive after the buds have opened enough to allow them to crawl into the narrow cracks between the expanding leaves. It is instinctive with these larvae to get out of sight as soon as possible, and once inside the opening buds with a few leaves tied together into a nest, sufficient food for the remainder of the larval life is protected in such a way as to make it difficult, if not impossible, to get the poison in contact with the food.

If on arriving at the bud, the larvae finds its sufficiently open to allow it to crawl in, in all probability very little food is taken from the surface parts. It, on the other hand the bud is still closed, more or less of the surface is eaten in boring to the center. If the part of the bud through which the larva eats its way is coated with a poison, a fatal dose may be taken but at this season of the year the buds are very rapidly swelling and a bud that is well coated one day may two days later, on account of the expansion of the surface parts, be so insufficiently covered as to be harmless to the larva that enters it. As is well known to all fruit growers, some trees expand their leaves earlier than others, and again peach buds open before most apple buds.

Again, after the bud may be said to be fully expanded the inner terminal growing shoot continues to put forth new leaves. These leaves are the ones that form the food of the larvae and they expand within the nest where they are not easily reached with a spray.

Considering how admirably the insect is protected by nature and its own habits, its control when in its spring nest is at least uncertain.

The problem is less perplexing when only nursery trees or trees in a young orchard are concerned. Under such circumstances hand picking of the nests should be very satisfactory. In picking the nests, however, care should be taken not to allow the larvae to escape to the ground for they would probably return to the trees. A pail, not a basket, should be used in gathering the nests, which should be burned or thoroughly saturated with kereosene oil. If left in a pile at the side of the field, the chances are that some of the larvae would complete their development to the moth and fly to the trees.

There seems to be some promise of good results from the use of summer sprays applied at the time the eggs are hatching. As is indicated on a previous page, the very young larva on hatching from the egg passes to the under side of some leaf where it spins a delicate tube from the end of which it issues for getting its food which it takes from the surface parts of the leaf. If this part of the leaf be coated with a poison, the treatment should be successful. It would be necessary to get the coating on before the larva spins its web on the surface. The spray should be directed against the under side of the leaves.

For this purpose we recommend the use of arsenate of lead in preference to Paris green on account of the much greater adhesive quality of the former insecticide. Arsenate of lead sticks to the foliage through severe rain storms and when applied in the spring may be found still adhering in the fall giving a whitish color to the leaves. For this reason it has a particular advantage in the treatment of the newly hatched larvae of the bud moth.

In controlling the insect we recommend the following:

- (1). Pick by hand and destroy the nests on nursery and young orchard trees.
- (2). Spray thoroughly with arsenate of lead in the spring of the year just as the buds are expanding.
- 3). Spray thoroughly with arsenate of lead about June 15. Give particular attention to coating the under surface of the foliage.

#### CONCLUSION.

This is a serious insect pest and one that the fruit grower would do well to become familiar with and suppress before it takes possession of his orchard.

## THE OYSTER-SHELL BARK-LOUSE.

*Lepidosaphes ulmi* (Linn.)

This widely known injurious species is the only scale insect of importance to the fruitgrower that, so far as is known to the writer, has been recognized in Montana. It appears to be generally distributed in the state, particularly west of the main divide, where in some cases it has proved to be a serious enemy to apple trees. One orchard of 800 trees in the Bitter Root valley is so badly infested as to show its sickly condition at a considerable distance. Nearly every smaller limb and twig on the greater number of the trees is thickly incrustated.

There can be little doubt that this scale insect, which was known in Europe upward of a century ago, was imported into America on nursery stock by the early settlers and later transferred to Montana from other parts of the United States in the same way.

### FOOD PLANTS.

The oyster-shell bark-louse has been recorded on a large number of food plants, the total number for America being about forty. The list included, beside apple and pear, various other fruits and practically all the more important shade trees of northern United States.

Dr. Howard has suggested that eventually two species instead of one may be found in the series in the list of food plants.

### LIFE HISTORY AND HABITS.

If during the winter one of the female scales be turned over it will be found to contain a mass of very minute yellowish-white eggs, and in the pointed anterior end of the scale, the shrivelled body of the female. Dr. Howard has found the eggs under each scale to vary in number from 42 to 86.

In the New England states these eggs hatch about the first of June, varying in different years according to the forwardness of the season. We have had but little opportunity to make observation on this point in Montana, and have but one record. On June 5, 1903, none of the eggs had hatched at Lo Lo. The young (Fig 3, c.) are able to walk immediately after hatching, and working their way out

from under the protecting cover of the parent scale they crawl to other parts of the twigs, principally to the young shoots which at that time of year are tender and succulent. In rare cases they settle on the fruit of the apple and pear.

After settling down and inserting into the bark the long thread-like hairs through which the juices of the plant are extracted, the

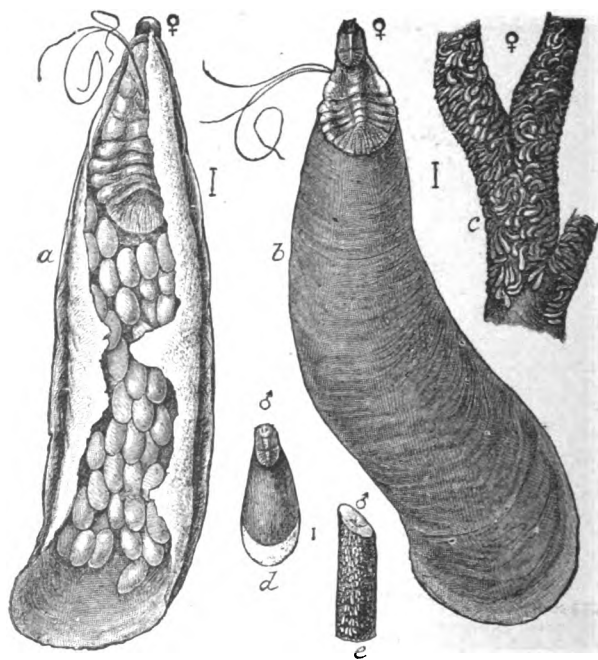


Figure 2.—Oyster-shell Bark-louse. a, female scale from below showing eggs; b, same from above, greatly enlarged; c, female scales; d, male scales enlarged; e, male scales natural size. (Howard, Yearbook, U. S. Dept. of Agr.)

insect goes through remarkable changes. From pores in the back, principally at the hinder part of the body, a glandular secretion appears, and from it the scale is formed. The female molts or casts the outer skin twice and the male once. The cast skins are incorporated in the scales (See Fig. 2, b). After molting both sexes continue to grow, the female attaining a much larger size than the male; com-

pare b. and d. of Fig. 2 The scales indicate approximately the comparative sizes of the insects under them. The mature male and female are very dissimilar in appearance. The male has long antennae, a pair of eyes, three pairs of legs, one pair of wings and at the end of the abdomen a long sharp-pointed organ. The female has no antennae, eyes, legs or wings, these parts all being lost in the first molt. When mature, the body of the female reaches to the posterior end of the scale, but as the eggs are laid the body shrinks and becomes shortened and when the full number of eggs has been laid it may be found lifeless, at the anterior end, the cavity under the scale now being occupied with the eggs. As previously stated, in this condition the insect passes the winter. The adult male and female are shown at Fig. 3.

In the northern part of the United States there is only one annual generation but in the South there are two.

### REMEDY.

Insects of this character, covered as they are by a scale that fits closely to the bark, are not easily killed by contact insecticides. The most vulnerable point in their life appears to be just at the time the young are hatching and settling on the bark. We have previously recommended the use of kerosene emulsion as a remedy for this insect, in the strength of one part to nine of water. Various reports to the effect that this treatment has not been effective in Montana, have come to this office, but inquiry has shown that in all these cases there is no certainty that the application was made at the correct time. We can do no better than to repeat our previous recommendation to watch closely for the hatching of the eggs about the first of June and spray with with kerosene to the strength above mentioned, after the young have hatched. If, after a few days, more living lice are found the treatment may be repeated.

### EXPERIMENTS WITH LIME, SULPHUR AND SALT WASH AS A REMEDY.

We take this opportunity to present the results of experiments conducted at Lo Lo, Montana, in the early spring of 1903, for the

purpose of determining the value or non-value of the lime, sulphur and salt wash, and certain modifications of the wash, as a means of destroying the eggs of this scale insect.

The experiments were conducted in the apple orchard of Mr. Delaney. At the time, pear buds were swollen almost to the point of expanding their first leaves and apple buds were slightly swollen.

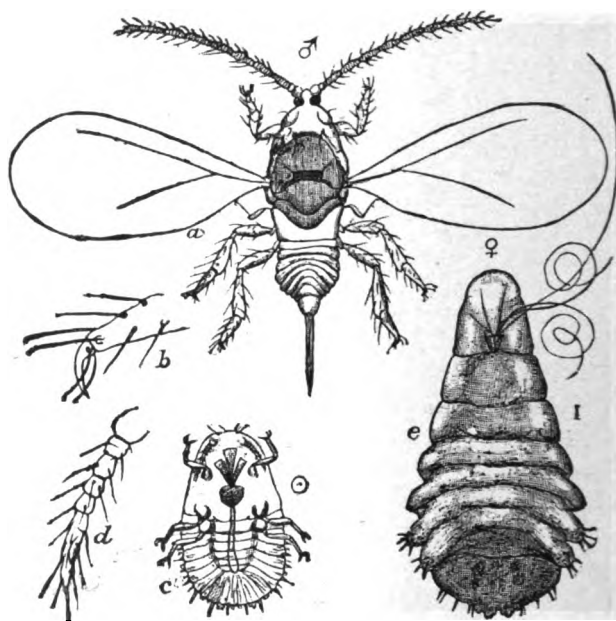


Figure 8. Oyster-shell Bark-louse; a, adult male; b, foot of same; c, young larve; d, antenna of same; e, adult female taken from scale; a, c, e, greatly enlarged; b, d, more enlarged. (Howard, Yearbook, U. S. Dept. of Agr.)

The trees are large and were badly infested with this insect. Seven to nine trees were used in each experiment, each lot being sprayed with a different mixture, but the total number of trees used constituted but a small proportion of the orchard. The spraying was done April 21 and 22.

One lot was sprayed with the wash as follows:

Lime .....	1 pound.
Sulphur .....	1 pound.
Salt .....	1 pound.
Water .....	4 gallons.

Lot two was sprayed with the following:

Lime .....	1 pound.
Sulphur .....	1 pound.
Water .....	4 gallons.

Lot three was sprayed with:

Lime .....	$\frac{1}{2}$ pound.
Sulphur .....	1 pound.
Water .....	4 gallons.

In the fourth lot lime only was used as follows:

Lime .....	1 pound.
Water .....	8 gallons.

Two subsequent visits were made to the orchard, one before the hatching of the eggs and one after, but I could not find the least evidence of any good having been accomplished by any of the four treatments.

## APPLE LEAF-APHIS.

*Aphis pomi* DeG.

A few years ago practically all the accounts of plant lice on the foliage of apple trees were written of one species, which was known under the scientific name, *Aphis mali* Linn. Dr. John B. Smith, of Rutgers College, New Jersey, and others, had noticed that accounts of the insects in other localities did not agree with their own observations, but not until Prof. E. Dwight Sanderson\* published the results of his investigations, was it made clear that, instead of having one apple aphid in the United States we have several.

We have at least two species in Montana, but one of these, the Apple Leaf-aphid, is far more common than the other and is responsible for practically all the injuries.

### CHARACTER AND EXTENT OF INJURY.

No fruit pest has been more frequently inquired about in the letters to this Station than has this aphid. These letters, as well as the writer's experience in various parts of the state, show conclusively that the species are very troublesome and at times a very injurious pest. It is universally felt that as a rule young trees are much more susceptible to attack than trees in bearing. The writer's field notes record one notable exception to this in the case of a large orchard in Flathead county, composed of trees which had been in bearing for many years, which were so badly infested as to have the foliage withered, and the fruit undersized and poor.

A prominent characteristic of the work of the aphid is the curling of the leaves. In this respect there is a marked difference between the effect on the tree of the work of this species and of "Fitch's apple aphid," which, on the whole, is more common in the United States. In curling, the deformed leaf usually takes a characteristic shape. The surface becomes irregularly raised and the whole leaf curls bringing the under surface inside and the upper surface exposed. The tip of the leaf rests upon its base, not in the middle, but to one side

\*Thirteenth Annual Report of the Delaware College Agricultural Experiment Station.

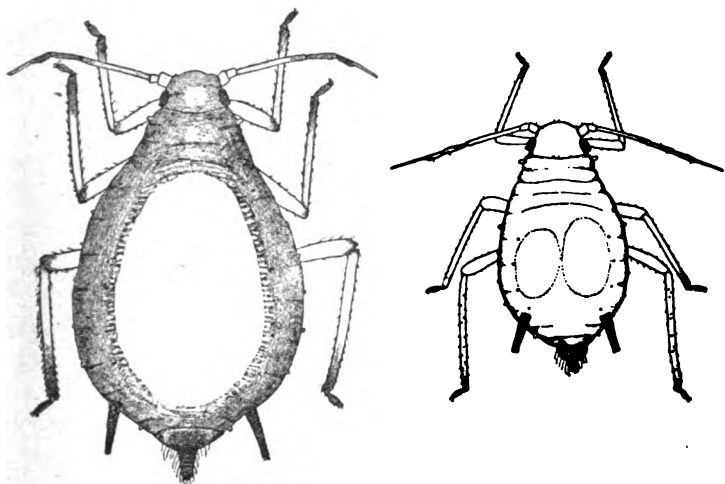


Figure 4. Wingless viviparous female on left; oviparous female on right—greatly enlarged. (Sanderson, 13 Ann. Rept. N. J. Exp. Station).

or the other of the mid-rib. The lice live inside of the curled leaf, a fact which has much to do with the difficulty in controlling them with insecticidal sprays.

There is some reason to believe that the presence of the lice in large numbers on a tree has the effect of keeping the sap in the tree late in the fall, thereby making it more liable to injury by cold weather. It is certain that badly infested leaves on the ends of the new growth often fail to mature and remain on the tree throughout the winter. This is often noticeable on trees in the nursery row.

The general injurious effect of the lice is to check the normal growth of the tree. This office has many records of this effect in a serious degree.

We have never found this louse occurring in great numbers on the young buds in the spring as is often the case with "Fitch's apple aphid." As a rule, only a few scattering lice are to be found early in the season, and our experience has shown that frequently only here and there a tree will be found infested in the spring of the year, though as the season progresses the lice will gradually spread throughout the orchard.

## DESCRIPTION AND LIFE HISTORY.

Like many other plant lice, the apple-aphis passes the winter in the egg state. In the spring the eggs hatch, producing very minute, dark greenish lice which may be found crawling about over the surface of the bark or closely nestled on the young buds and expanding leaves.

The spring of 1902 was looked upon as being very cold and backward in the Gallatin valley, and the writer was much surprised in going into the Station orchard on April 16th to find an abundance of newly hatched lice. The buds had not started and were no more swollen than they were the fall before. There had been a few days of hot weather which had caused the lice to hatch, but had not been of long enough duration to start the buds. Part of the lice had been feeding and had distinctly increased in size.

On April 19 a cold storm came and on the 20th there were about three inches of snow. For the next few days the writer was out of town, but on May 1 the trees were examined and the lice were found to have been nearly all killed. Only two living ones could be found and many dead bodies were still attached to the twigs. Since that

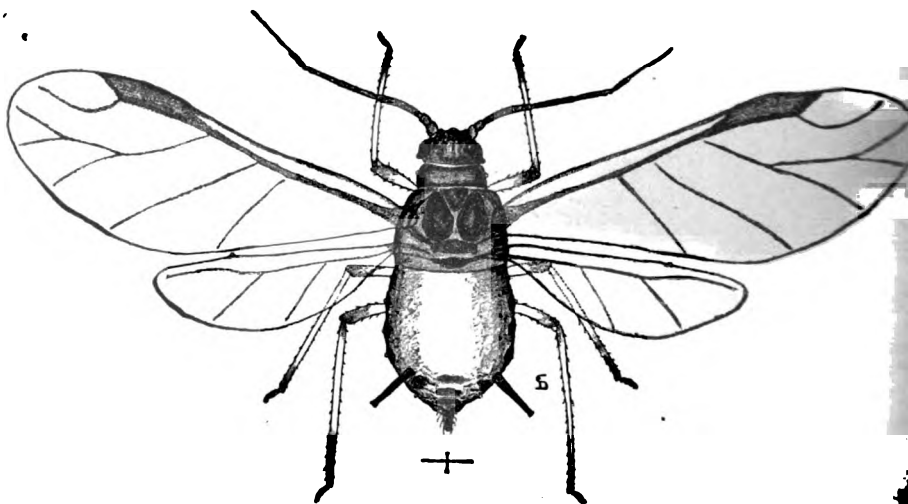


Figure 5. Winged viviparous female greatly enlarged. (Sanderson, 13th Ann. Rept. N. Exp. Station.

time, we have observed a similar, though less extensive, early hatching and killing of the lice.

If not destroyed by natural enemies or climatic conditions, the young lice in due time become mature and begin to produce young. Dr. Smith of New Jersey\* found that about fifteen days were required for the first generation to reach maturity after hatching. The lice are known as the "Stem mothers," (See Fig. 4, b). They are wingless and are greenish in color. No males are produced from the eggs and the stem mothers are able to produce young without them.

The young of the second generation (offspring of the stem mothers) are produced alive—not hatched from eggs—and are able to begin feeding almost immediately. They settle down near the mother and one may often find a stem mother with her large family close by her. Our office notes show that the stem mother gives birth to young at the rate of from one to fourteen per day, and that she continues day after day for fully eighteen days, producing an average

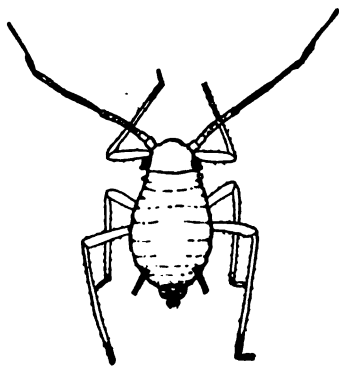


Figure 6. Male of the oviparous generation greatly enlarged. (Sanderson 14th Ann. Rept. N. J. Exp. Station.

number of about six or seven. Thus each stem mother produces fully 100 young.

\*Bulletin 143 of the N. J. Experiment Station.

Dr. Smith found that the second generation matures in nine or ten days and that of this series about three-fourths are winged; that the third series matures in about two weeks, less than one-half being winged and that thereafter no more winged forms appear but that seven series of parthenogenetic females in all appear before the end of the season. The 8th and last series is made up of males and females. Late in October, after the mating of the sexes, the females deposit the eggs which remain on the trees during the winter. Figure 4, right hand figure, shows an oviparous female. Figure 6, a male of the oviparous generation.

A part or all of the winged individuals of the early generations fly to other trees. A winged parthenogenetic female is shown at Fig. 5.

The eggs are minute, glossy black objects, oval in shape. They may be found on any part of the tree from the base of the trunk to the tips of the twigs, and are usually more abundant in the crevices of the bark and around the buds than on the exposed, smooth surfaces.

A very large proportion of the eggs, probably upward of 90 per cent, failed to hatch during the three years that we had the species under special study.

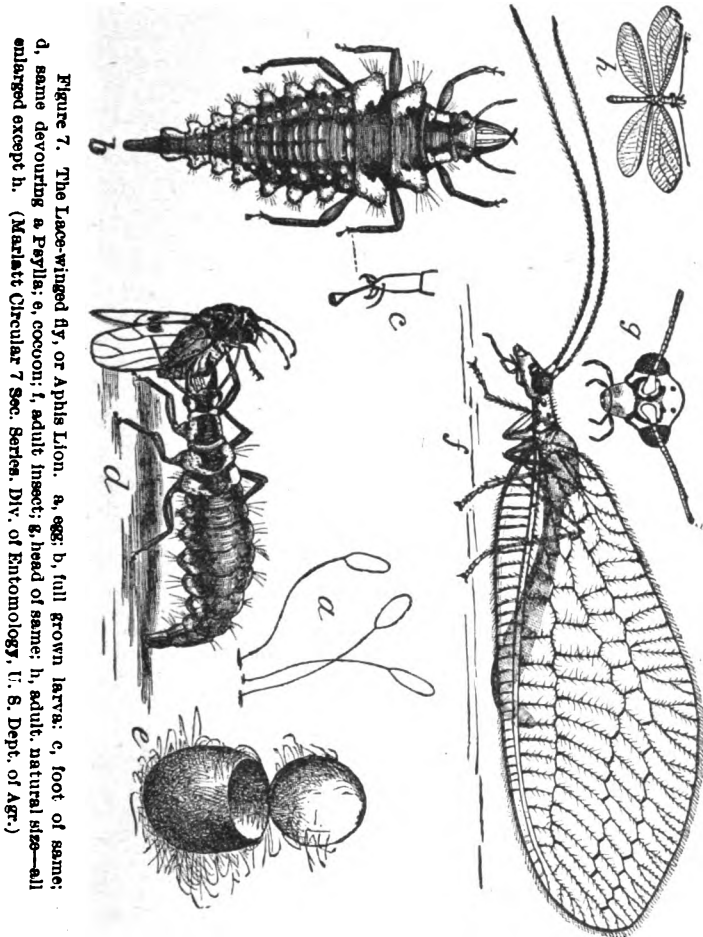
#### NATURAL ENEMIES.

Of the various natural enemies that feed upon the plant louse, none is of greater value than the Fire-marked Lady-bug (*Hyperaspis 5-signata*). Next in importance are certain species of syrphus flies. Besides these we have observed a Braconid parasite, a small fly that has not yet been named and the "Aphis Lion."

After two years of close observation of the habits of this lady-bug we are prepared to say that it is a very prominent factor in the prevention of the aphid from becoming exceedingly abundant and destructive. During the latter part of May and in June the beetles were found in great numbers in the Experiment Station orchard, and in various other orchards, running rapidly over the limbs and twigs in search for the young aphids. The number they eat when in confinements is astonishing.

In a previous paragraph we have called attention to the fact that only a comparatively small number of stem mothers are to be found

early in the season and that the large numbers to be found later in the season is the result of the rapid multiplication. It is apparent,



therefore, that the comparatively small number of lice that the beetles eat early in the season must have a great effect in the abundance of the lice later in the season.

Though the larvae of this lady-bug eat large numbers of the lice later in the season when they have become very abundant, we look upon the work that they do as being of much less value than that of the adults.

The Surplus fly larvae are probably of greater usefulness than the larvae of the lady-bug since they are usually more abundant, but like the beetle larvae, they do not appear on the scene until the lice have become abundant and are multiplying with such rapidity that it would require a large number of destroyers to dispose of the increase alone. Figure 8 illustrates a common species of lady-bug of the East, while at Figure 2, plate 1, is shown an adult of the species here discussed. Figures 3 and 4 of the same plate show the eggs of the same species and at Figure 5 is shown a full grown larva.

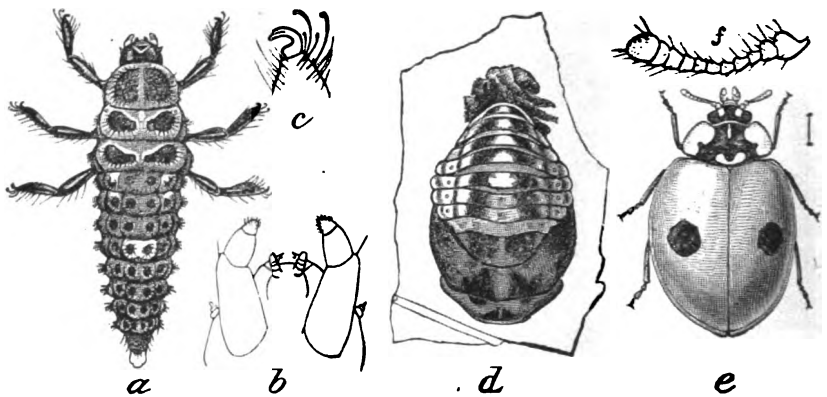


Figure 8, The Two Spotted Lady Bug; a, larva; b, mouth parts of same; c, claw of same; d, pupa; e, adult; f, antenna—all enlarged. (Marlott Circular 7, Sec. Series, Division of Entomology U. S. Dept. Agr.)

### REMEDIES FOR APPLE LEAF-APHIS.

In spraying for this aphid we would emphasize the importance of watching for the individual infested trees here and there in the orchard and treating them before the lice spread to the other trees. In other words, the spraying for the apple leaf-aphid should be done and out of the way early in the season, for under ordinary circumstances, when vigorously fought early in the summer, though some lice escape, there will be so few left that the natural enemies will be able to keep them from overrunning the orchard.

The value of prompt treatment is apparent when we realize the enormous power of multiplication with which nature has endowed these insects. In a previous para-

graph we have shown that the stem mother's maximum power of production is upward of 100 young, and it is probable that later generations can give birth to a similar number.

Acting on the basis that all of the young of each generation come to maturity and produce the full unumber of young, we find that the progeny of one stem mother during one summer is something enormous.

1st generation .....	1 aphid.
2nd generation .....	100 aphids.
3rd generation .....	10,000 aphids.
4th generation .....	1,000,000 aphids.
5th generation .....	100,000,000 aphids.
6th generation .....	10,000,000,000 aphids.
7th generation .....	1,000,000,000,000 aphids.

Thus starting with one aphid in the spring we would have in the seventh generation one trillion aphids, a number which the human mind cannot appreciate. Under natural conditions, however, the insects are decreased in number from one cause and another, all thro' the season, so that, while they increase very rapidly, they never do so to the extent above indicated. At the same time, however, it is easily seen that the destruction of a large proportion of the first and second generations will very markedly affect the numbers throughout the season. There seems to be little doubt that the killing of the first generation, by inclement weather in some seasons and the absence of storms in other seasons account for the great variation in abundance and destructiveness of this louse in different seasons.

Because of the great difficulty in controlling the insect after the leaves of the trees have become curled, the writer has undertaken to learn if it is feasible to destroy it in other ways. An extensive series of experiments in fumigation with the deadly hydrocyanic acid gas was conducted. In these experiments we used a large canvas tent, a large paper box and a small air-tight wooden box constructed for such work. We will not at this time give the detailed results of these experiments but will indicate the lessons they taught. Detailed instructions for the use of this substance will be found on another page of this report. (See index.)

We found that every aphid could be killed without the least injury to the foliage. Even though the experiments were conducted in both cloudy and bright, hot weather, not a leaf was injured in the whole series of tests.

We used the cyanide in strengths varying from 0.10 grams per cubic foot of inclosed space up to 0.30 grams and while 0.10 gram killed practically all the lice, and, on the other hand, 0.30 did not injure we decided upon 0.20 gram per cubic foot as being the suitable amount to use in practical work.

The time of exposure was 20 minutes.

Considering the fact that by a timely and persistent use of sprays and washes the aphid may be brought under control, I very much doubt if this treatment should be considered as a suitable remedy except in the case of very large owners or in company orchards where the expense of providing a complete fumigation outfit would be justified. Having the equipment already at hand it would cost about 4½ cents per tree to treat a large orchard.

Information regarding fumigation boxes suitable for such work as this may be obtained from Professor Johnson's work on fumigation published by the Orange Judd Publishing Co., New York.

We also undertook a series of experiments with the use of the lime-sulphur and salt wash as means of destroying the egg during the winter. We sprayed a series of trees with this wash and modifications of it in the Experiment Station orchard and at Lo Lo. Subsequent examinations of the trees at Bozeman showed that while none of the eggs hatched on the trees that were sprayed they also failed to hatch on all the other trees in the same part of the orchard that had not been sprayed. We therefore felt that the experiment had taught us nothing. The Lo Lo experiment also failed to be of value for the same reason.

During the past few days a bulletin from the Idaho Experiment Station, written by Professor Aldrich (Bulletin No. 40) entitled "Winter Spraying for Aphid Eggs" has come to my desk. The bulletin gives in detail Prof. Aldrich's experience in the use of seven different sprays used in the winter treatment of eggs of this aphid. The seven sprays are the following:

1. Pure kerosene.

2. Kerosene emulsion, one-third kerosene.
3. Kerosene emulsion, one-fifth kerosene.
4. Sulphur and lime wash, 1-1-2. (One pound sulphur, one pound lime, two gallons water.)
5. Sulphur and lime, 1-1-4.
6. Sulphur and lime, 1-1-8.
7. Crude petroleum emulsion, 10 per cent. strength.

From the results of his experiments Prof. Aldrich drew the following conclusions:

"Crude petroleum could not be uniformly applied. The emulsion was very unstable, and the oil is much too thick to apply pure. No damage resulted to the trees, but in many cases the eggs of lice were not destroyed.

Pure kerosene seriously injured the trees to which it was applied, but killed all the eggs.

Kerosene emulsion of one-third strength injured the foliage to some extent, though not very seriously; it did not kill the eggs with any uniformity. In one-fifth strength it did not injure the foliage, but was not at all effective in killing the eggs.

Sulphur and lime did not injure the foliage in the least, however strong. In the 1-1-2 and 1-1-4 proportions it killed almost all the eggs; it is a question whether the very few that hatched had not been missed by the spray.

Of the seven kinds of spray used, the choice for commercial purposes would undoubtedly be No. 5, sulphur and lime in the 1-1-4 proportion, or what is called the "Piper formula."

1-1-4 proportion is probably a successful winter treatment, it will be applicable only on small trees that can be closely examined and thoroughly sprayed.

In conclusion, we recommend that Montana apple growers make careful, conclusive tests of the 1-1-4 lime-sulphur wash as a winter treatment, and mean while place their main dependence on the use of kerosene emulsion and whale-oil soap or quassia-whale oil soap solution, spraying trees that are generally infested and dipping the

He further concluded that while the lime-sulphur wash in the extremities of limbs that are infested only at the ends of the branches.

Formulae for these washes are given on a later page. (See index.)

## THE FLAT-HEADED APPLE-TREE BORER.

*Chrysobothris femorata* Fab.

One of the most troublesome insect pests with which the Montana fruit-grower has to contend, is an apple-tree borer, which in the larval stage is expanded and flattened near the anterior end, as shown in figure 9, a, an appearance which has led to its being called "the flat-headed borer." Besides attacking the apple, the borer has been recorded also on various other deciduous trees, among which are pear, peach, oak, maple, mountain ash, box-elder, hickory, chestnut, sycamore, horse chestnut, redbud and currant. Mr. F. H. Chittenden of the U. S. Dept. of Agriculture, from whose circular, (Circ. 32, Division of Entomology) many of the facts in this paper are taken, states that cherry, beach and white birch are probably food plants, while an unknown authority has stated that elm, tulip, and cottonwood are also host-plants.

Although not considered to be a pest of first class importance this species has been doing a great deal of damage in this state, particularly in the Bitter Root valley, and there is an increasing demand for information concerning its habits and the means of controlling it. It has been particularly destructive on young orchard trees, girdling the trunk near the ground and killing the trees. The accompanying photograph (see Plate III, Figure 7) shows the manner in which many trees have been affected and killed in Montana. The only explanation the writer has to offer as to the cause for the rather unusual numbers of this insect, is that under the climatic conditions in Montana trees seem to be affected to a considerable extent with sunscald, an affection which leaves the trees in an inviting and favorable condition for this insect. It has long been known that this insect prefers for a breeding place trees that have been previously weakened by some other cause. Observation has shown that trees which have been injured on the side exposed to the winter's sun are often selected by the adult in depositing their eggs.

Young trees are affected principally on the main stem close to the ground, but on old trees the borers work on any part of the tree except the smaller limbs and branches.

Like other members of the same family of beetles (Buprestidae) the adults are diurnal in habits and are most active during the heat of the day. By a close search in an infested orchard during the season of the year when the adults are out, one may find them basking in the sun on the trunks of the trees and on prostrate logs.

#### DISTRIBUTION AND OCCURRENCE IN MONTANA

The flat-headed apple-tree borer is a native of North America insect. In spite of this fact, however, we believe that it is an introduced species in Montana. None of its principal food plants, so far as known, are native to the state, or if present, occur only sparingly, and moreover, its presence has been detected only in restricted localities. We think it much more probable that the insect was brought into the state on some of the earliest shipments of trees from the older apple growing regions.

It is a widely distributed pest throughout the United States east of the Rocky Mountains, and in southern Canada.

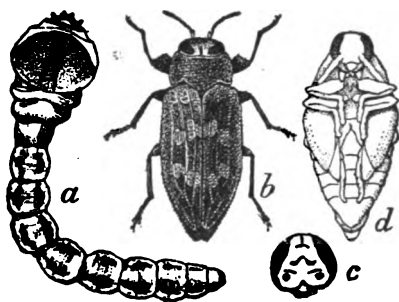


Figure 9. Flat-headed Apple-tree Borer.  
a, larva; b, beetle; c, head of male; d, pupa  
—twice natural size. (Chittenden, Circular  
32, Sec. Series, Div. of Entomology U. S.  
Dept. of Agr.)

#### LIFE HISTORY.

The eggs, which are pale brown and about one-eighth of an inch long, are laid on the trees during the hot summer months. One observer, Dr. Riley, found them being laid from June to September, but our observations in Montana indicate that while a few beetles may be found on the trees later in the season the majority are out and

depositing their eggs late in June, and early in July. In about three weeks the eggs hatch and the young larvae bore under the bark, where they feed for three years, first just under the bark and later in the woody parts of the stem. On young trees they most commonly occur at about the surface of the ground as shown in the photograph above referred to. The location of the burrow may often be detected from the outside by the discoloration or slightly sunken condition of the bark.

At the end of three years from the time the egg was deposited the beetle bores out from the pupal chamber which it constructed at the end of its larval life. The sexes mate and the eggs are deposited for the new generation.

#### NATURAL ENEMIES.

The downy wood-pecker which is so common in Montana and which is so often seen in our orchards, is the fruit-grower's friend. Besides picking up miscellaneous pests it locates burrows of this borer and extracts them in considerable numbers. In the older orchards of Montana scarcely a tree can be found that does not bear the marks of wood-peckers, a large proportion of which are made by this species.

#### METHODS OF CONTROL.

Borers as a class of pests are difficult to control. When once in a tree they cannot be reached with an insecticide. They may in many cases be removed by means of a sharp knife and a wire but their presence is not usually detected until a large part of the damage has been accomplished, and the injury done to the tree in removing the larvae may be greater than would be done if they were left to do their worst. It has been found, therefore, that clean, strong, cultural methods and the use of deterrent application on the trees, both of which are preventatives, constitute the best means of control.

In the first place, in planting out a young orchard the trees should not be allowed to become weakened and so rendered liable to attack. Young trees in an exposed position should be protected against the strong rays of the winter's sun. The alternate thawing and freezing on the exposed side of the trunk produces the condition

known to all as sun-scald, and makes typical conditions for the borers. Dead or worthless trees should not be allowed to stand and become a menace to the healthy ones. It is a bad practice to have a brush pile made up of dead trees and prunings at the side of the field. Such piles should be burnt very frequently, for they soon become nurseries of pests.

In a locality known to be infested with this borer it is often desirable to use deterrent applications on the trunks and larger limbs of both weakened and healthy trees. For this purpose, a number of substances have been recommended. Some use old newspapers as mechanical barriers placed about the base of the tree.

Mr. Chittenden recommends that these papers be put on the trunk for about two feet from the ground up, and that above the paper a carbolated or alkaline wash be applied. Wire netting is sometimes used.

The paper and netting not only prevent the deposition of eggs but also prevent the escape of the beetles that emerge underneath them.

Among the substances that may be used as washes to make the surface of the trees objectionable to the adult beetles and so prevent them from depositing their eggs are the following:

1. A thick solution of whale-oil soap.
2. Soft soap rendered thick by the addition of caustic soda or potash in solution.
3. Either of the above washes would probably be made more effective by the addition of crude carbolic acid at the rate of one pint to ten gallons of the wash.

James Good, 939 and 941 North Front Street, Philadelphia, Pa., offers for sale a product known as Caustic Potash Whale-oil Soap, which of itself would be a good substance for this purpose. It should be diluted with sufficient water to make a thick fluent mass, and applied to the trunk and limbs of the trees to be protected. Such washes when not of a quality that makes them injurious to the hands, are sometimes applied by a man wearing old mittens or socks that are saturated with the wash.

## THE PEAR-LEAF BLISTER MITE.

(*Phytoptus pyri* Scheuten.)

Though probably of European origin the pear-leaf blister-mite is now widely disseminated throughout the world, having been distributed by the agency of traffic in nursery stock. It is sparingly distributed in Montana, but where well established is a troublesome pest.

### NATURE OF INJURY.

As the leaf-buds of affected trees unfold in the spring there may be seen red blister-like spots and blotches which in severe cases may involve practically all the surface of the leaf. At first the galls are more distinctly seen on the upper surface of the leaves but later in the season the spots turn brown, owing to the death of the tissues comprising the blisters, when the affected spots become more apparent on the under side of the leaves. The blotches often take the shape of elongated patches one on each side of the midrib.

In each blister, on the under side of the leaf, may be seen one or more minute holes that lead to the cavity of the blister and usually visible only under a lense or microscope.

Within these blisters composed of abnormal plant tissues, the mites live, feeding on the juices of the plant. Under the shelter of these galls they are very well protected, not only from wind and rain which might easily sweep them off, but also against insecticidal treatment. The tissues on the inside of the galls also furnish better facility for the mites to acquire nourishment than would the thicker layers of cells on the surface. The freshly formed galls are thick and succulent, but as they die and turn brown they shrivel and dry. Badly affected trees lose their foliage long before the normal time which must be an injury to the health of the tree.

### THE MITE.

The mites that produce these galls are very minute, being scarcely visible to the naked eye. Under a high power microscope, the body is seen to be elongated in form, about four times as long as wide, and has the appearance on the surface of being made up of

a large number of fine rings. There are four legs, all of which are placed at the anterior end of the body and though small they enable the mite to move rapidly. The head is made up chiefly of a conical snout within which are two lance-like jaws. To cover a linear inch about 150 mites placed end to end would be required.

### LIFE HISTORY.

From the eggs which are laid in the galls by the parent mites the young hatch, and, crawling out of the hole, go in search of an uninjured spot in the leaf. Then, boring through the surface they start new galls. The mites remain in the galls until the end of the season when they crawl to the buds and seek shelter for the winter under the scales.

Some mites remain on the leaves too long and are borne to the ground when the leaves fall.

### MEANS OF DISTRIBUTION.

Of itself the mite cannot travel far. For distant dissemination it is dependent upon outside agencies and has doubtless been spread from country to country on nursery stock. From tree to tree in the same vicinity they may be carried on the feet of the birds, or blown by the wind on the leaves in the fall of the year.

### REMEDIES.

The only vulnerable point in the life cycle of this mite is when it is secreted under the bud scales after the leaves have fallen. Prof. M. V. Slingerland found that the mite "can be nearly exterminated in a badly infested orchard by a single thorough spraying of the trees in winter with kerosene emulsion diluted with five to seven parts of water." In all cases of treatment with a spray or winter wash, we recommend that no twigs or branches that have been pruned off be left on the ground.

We recommend that the leaves from infested trees be gathered and burned and not allowed to blow about.

Having learned from various fruit-growers of the state that they had not found the kerosene emulsion treatment to be satisfactory,

the writer undertook a series of tests of the lime-sulphur-salt wash as a remedy. The experiments were conducted in the orchard of Mr. C. M. Allen of Lo Lo. I would here express my gratitude to this gentleman for many courtesies extended to me, both in connection with these experiments and at other times.

In the experiments Mr. Allen's entire orchard of 190 trees was used and we feel entire confidence in the results we obtained. The spraying was done on April 21 and 22, the pear buds being swollen almost to the point of opening.

In the various tests we used the following:

Spray No. 1.

Lime .....	1 pound.
Sulphur .....	1 pound.
Salt .....	1 pound.
Water .....	4 gallons.

Spray No. 2.

Lime .....	1 pound.
Sulphur .....	1 pound.
Water .....	4 gallons.

Spray No. 3.

Lime .....	½ pound.
Sulphur .....	1 pound.
Water .....	4 gallons.

Spray No. 4.

Lime .....	1 pound.
Water .....	8 gallons.

Ten trees were used in experiment No. 4 (lime and water only) and ten trees were left unsprayed. The remaining trees were about evenly divided in experiments Nos. 1, 2, and 3.

The results of the tests were very satisfactory and seemed conclusive. The mites were practically exterminated on all trees treated with sprays 1, 2, and 3. The mites on the ten trees sprayed with No. 4 were, so far as we could determine, wholly uninjured. These trees and the ten left unsprayed were badly affected with the mites after the foliage expanded.

Directly the other side of a barbed wire fence are more pear trees badly affected with the mite. The two pear orchards are really

but one, since Mr. Allen's orchard was purchased and fenced off from the other larger one, the fence, in fact, passing diagonally through one row. The trees on the other side of the fence were badly infested the following summer, thus giving us greater confidence in the efficiency of our treatment.

It appears that all of the first three sprays were equally effective. Spray No. 3  $\frac{1}{2}$ -1-4 contains only enough lime to cause the sulphur to go into solution, thereby making the caustic ingredient of the mixture. The spray when ready to apply is clear and transparent instead of milky as is No. 2, which has an excess of lime. In spray No. 1, the excess of lime goes onto the tree merely as a whitewash. We are not prepared to say that there is not some benefit in having this excess of lime, and for the present we recommend the use of spray No. 2. We do not feel that the addition of salt in spray No. 1 renders the wash of any more value.

In conclusion, we recommend, as a means of holding this mite in control, a thorough spraying with lime-sulphur-salt wash in the 1-1-4 proportion, in the spring of the year before the buds open. Directions for the preparation of this wash will be found on another page of this report. (See index.)

## GRASSHOPPERS.

During the past three years a considerable amount of damage was done by grasshoppers in eastern Montana. An extensive territory was more or less affected, in some localities the grasshoppers being so abundant that there was no vegetation left. From this extreme there was every gradation down to no injury. During these three years the grasshoppers steadily increased and the seriously affected territory was extended.

The injuries have been principally confined to the fenced and open ranges used by the stockmen in grazing cattle, sheep and horses. but some damage was done to grains, cultivated grasses and alfalfa. We received reports also of damage to fruit trees and to garden crops.

Coincidental with the appearance of the grasshoppers has been a series of years in which the rain and snowfall has been much below the average. Aside from any direct or indirect influence which this scarcity of moisture may have had on the unusual increase of grasshoppers, it certainly very much shortened the crop of grass. While the amount of grass that the grasshoppers ate would have been missed even if there had been a full growth, it is certain that what they took was more seriously missed on account of the scarcity of grass.

Roughly speaking, the territory injured through the combined effects of dry weather and grasshoppers may be said to be embraced in that part of Montana drained by the Yellowstone river east of the town of Big Timber. Not only were the valleys of the tributaries of the Yellowstone affected but the cross country as well. We also received reports of injury in other scattering localities. One report came through Townsend from the country northeast of that town and we were notified of injury on the range in the eastern part of Madison county.

One species, the yellow-winged locust, was very abundant in restricted localities in and about the Gallatin valley. We also noted the big-headed grasshopper to be more abundant than in previous years and in two instances the yellow-striped locust was found in great numbers in the edges of this valley.

## INJURY NOT CAUSED BY THE ROCKY MOUNTAIN LOCUST.

Many persons have supposed the "old-fashioned" or Rocky Mountain Migratory Locust to be responsible for the losses in Montana. Our investigations of the subject, however, show that no one species is alone the cause of the loss and the above species (*Melanoplus spretus* Uhler) if present in the state at all is very rare. During the five summers that I have been collecting in all parts of Montana I have not captured a single example of this interesting species. Moreover, I learn by letter from Prof. Gillette of Colorado that he has had a similar experience, having been unable to find any specimens during a longer period in his state.

In our various trips into the worst affected regions we found a fairly uniform state of affairs throughout. On the range two or three species, taken together, constitute a large proportion of the total number, though in restricted localities one or another species besides these was more abundant. The three most common species on the range were the Big-headed locust, (*Aulocara elliotti*), the Lesser Migratory locust (*Melanoplus atlaniis*) and the Yellow-winged locust (*Camnula pellucida*). In point of abundance the Big-headed grasshopper was the leading species of the three. The Lesser Migratory Locust was second in importance. It prefers the dryer uplands to the irrigated valleys, but in many cases it was found in great abundance in grain fields, particularly on the benches and in non-irrigated fields.

The Yellow-winged Locust is more local in its distribution, often occurring in immense numbers in restricted localities and at times becoming very injurious to grasses and grains.

We found the two-striped locusts to be common in practically all the cultivated fields that were injured by grasshoppers. This species was particularly injurious to alfalfa, the succulent stems and leaves of this plant apparently suiting its taste.

## LIFE HISTORY.

All our particularly injurious species are alike in the main features of their life history. The winter is passed in the egg stage in

the ground. The eggs are about one-fifth of an inch in length and are deposited in compact masses or "pods" which are arranged vertically, or slightly inclined, just below the surface of the ground.

In making the hole in the ground to receive the eggs, the female makes use of special organs at the extremity of the abdomen. Placing the point of the abdomen against the ground the pointed organs work rapidly back and forth and as the hole is made the abdomen settles into the earth. When the hole is completed it is filled with the mass of eggs and a viscid frothy substance.

Prof. C. V. Riley's classic illustration of the process of egg-laying of the Rocky Mountain Locust, together with his description of the process, show that in that species the eggs are laid in four regularly parallel rows and that the number of eggs varies between 20 and 35. He also found that two or three such egg-masses were deposited by each female insect.

The two-striped locust lays a larger number of eggs than this for we have counted as high as 62, in a mass, and two or three masses are deposited. The Big-headed Locust (*Aulocara ellioti*) probably, deposits only two masses.

In general the places most chosen by the females for the purposes of egg-laying are those at which the soil is fairly free from grass-roots, or other roots that would interfere with boring the holes. Such places are found on the sides of roads, in abandoned roads, among tall weeds, etc. When the mating season comes the adults of a species gather into colonies where they stay for the remainder of their life. As a result, the young are often found in the spring of the year in more or less restricted localities.

In our investigations of the outbreak of grasshoppers in Montana in 1903 we found that the Big-headed grasshopper paid little attention to where the eggs were laid; for miles and miles over the denuded ranges the females could be found performing this act.

In the spring of the year, in some species earlier than in others, the eggs hatch into very small nymphs which on close examination are seen to resemble adult grasshoppers, but there are no indications of wings. As they increase in size and molt from time to time, rudimentary wings appear which increase in prominence with each molt, until the last when with fully developed wings the insect is mature.

and ready to lay eggs. While a few species of grasshoppers pass the winter as adults and a much larger number as nymphs, thereby making it possible to find some grasshoppers in the early part of the summer, it is a matter of common knowledge that they are much more commonly seen in August and September. This is not because there are more grasshoppers in the latter part of the season but because when winged they are much more conspicuous than in the younger stages.

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## MONTANA'S MOST COMMON AND DESTRUCTIVE SPECIES.

In the following paragraphs we present a few of the leading facts regarding the most common species of grasshoppers that we have taken in middle and eastern Montana. They are not arranged in the order of their importance except the first five or six. Not all the species discussed are of great economic importance but all are common and liable to be observed by anyone. Since some of the species are not yet known by vernacular names, we have used the scientific name of all, but have given also the popular name when one is known.

I am indebted to Prof. Lawrence Bruner of the University of Nebraska for valuable information concerning our species and for the determination of a large number of species including a part of those discussed in this paper. Dr. L. O. Howard of the Division of Entomology at Washington has also very kindly identified a number of species for me.

### *Aulocara ellioti* Thomas. THE BIG-HEADED GRASSHOPPER.

This grasshopper, in point of numbers, stands first in the series here discussed. While it has been mentioned as being injurious in various parts of the United States, it has never before been considered a prime cause of devastation. It occurs throughout western United States and is a true grass-eating species. When viewed from above or from the side the head is large (see figure) and the tibiae

are bright blue; the antennae of the male are long. It occurs principally on the range, in Montana, having seldom been found in irrigated valleys.

*Melanoplus atlanis* Riley. THE LESSER MIGRATORY LOCUST

This species is distributed throughout most of the United States and Canada and often becomes so abundant as to be injurious. In Montana we have found it in cultivated fields where it has occasioned considerable loss, and on the range where in association with *A. elliotti* it has been injurious. The tibiae are usually red. The size and general appearance of the species are shown on the accompanying plate (Plate IV, figures 1 and 2).

*Camnula pellucida* Scud. THE YELLOW-WINGED LOCUST.

It may be safely said that not a year passes in which this species does not become injurious in either one part or another of the United States, usually in the northwest. It feeds particularly on grasses and grain. In Montana it has been found to be local in its distribution and has been destructive on the range in only a few restricted areas. The under wings are yellow, the upper wings and general surface of the body are variable in color, between yellow and brown.

*Melanoplus bivittatus* Say. THE TWO-STRIPED LOCUST.

This is among the larger grasshoppers of Montana. It occurs throughout the greater part of the United States. It is especially injurious in cultivated fields and so far as our experience goes is practically the only species that has caused injury to alfalfa. The femora have longitudinal stripes and there are two yellowish stripes on the back.

*Hippiscus neglectus* Thomas.

We found this grasshopper to be fairly common over the larger part of the affected territory. Its appearance is well shown in the accompanying figure. (Plate VI, figure 2.)

*Spharagemon æquale* Say.

This grasshopper is often met with in the heat of the day, is a strong flyer and a difficult one to catch. In some places it was so common as to be somewhat injurious.

*Arphia tenebrosa* Scudder.

This grasshopper flies with a clattering sound, often poises itself in the air in the heat of the day, remaining in one spot with the wings rapidly vibrating.

*Chortophaga viridifasciata* DeG. THE GOAT-HEADED GRASSHOPPER.

This exceedingly variable species, found in the early part of the season, often assembles in colonies. It varies between bright green and dull brown.

*Dissosteira carolina* Linn. THE CAROLINA LOCUST.

This grasshopper is the species known to most people as the one that poises in the air making a peculiar rattling or rustling sound, settling to the earth as the sound dies out. It occurs commonly along dusty roads and hot, gravelly places as along railroad tracks. The writer has often observed it to be abundant in various parts of Montana.

*Cordillacris occipitalis* Thomas.

This species occurs on the plains east of the Rocky Mountains. We have found it very abundant in eastern Montana.

*Melanoplus dawsoni* Scudder.

This species when mature has rudimentary wings which reach only about half-way to the end of the abdomen. The under side is yellow, with prominent black bands on the abdomen. It has been common in lowlands in the Gallatin valley and in the Yellowstone valley.

*Encoptolophus sordidus* Burn. THE CLOUDED GRASSHOPPER

Often met with in the field and somewhat resembles *C. pellucida*.

*Acrolophitus hirtipes* Say.

This grasshopper of striking appearance, is uniformly green throughout. It occurs in restricted localities, often in considerable abundance, where in contrast to other sombre-colored grasshoppers, it is quite conspicuous.

## INSECT ENEMIES OF GRASSHOPPERS.

Grasshoppers have a large number of parasitic enemies and when the grasshoppers as hosts become abundant, their parasites, because of a plentiful supply of food, become numerous also and soon gain the mastery over the hosts. This balancing process is continually active. While we cannot say positively what is the cause of the appearance in Montana of grasshoppers in unusual numbers it is probable that parasites as a direct or indirect cause have had a great influence.

Various correspondents have called our attention to the presence of minute red spots on the bodies of grasshoppers. These red spots are the bodies of a red mite which occurs commonly throughout the state, and which doubtless does some good in preventing the undue increase of grasshoppers. They have often been mistaken for eggs of parasites but there is no reason for confusing the two, since the eggs of parasitic flies are white.

In every part of the grasshopper affected sections of the state that we visited in the summer of 1903 we found dead bodies of grasshoppers which contained maggots or larvae of a fly. Some of these were reared in the laboratory to the adult stage and the flies were sent to Dr. L. O. Howard for determination. He reported the fly to be *Sarcophaga cimbicis* Townsend. We are unable to state whether this fly killed the grasshopper or whether the larvae were merely feeding as scavengers on the dead bodies of grasshoppers that had died from other causes.

It was noticeable that a blister beetle or Spanish fly whose scientific name has not yet been determined was very abundant throughout the Yellowstone valley from Columbus eastward. We

received a few letters notifying us that these beetles had been injurious to garden plants and other plants of value. This species and various other of the same family (*Melodidae*) are well known to be very beneficial in the larval stage as destroyers of the eggs of locusts. In brief their life history is the following: In the latter part of the summer they deposit their yellowish colored eggs in the ground, each female producing four or five hundred eggs. The eggs hatch in about ten days into long-legged larvae. These larvae are very active and they run about over the ground searching for eggs of locusts, finding an egg pod they enter it and begin devouring the eggs. It is said that if two larvae come upon the same egg-pod a deadly combat occurs, resulting in the death of one or the other, leaving the successful contestant sole owner of the store of food. As the larva feeds and grows it molts from time to time producing remarkable changes, until in place of the long-legged larva there is one with short legs and rudimentary mouth parts. The mature beetle appears again the next spring.

Besides the enemies we have mentioned, which are among the most important, are many others which, taken together, doubtless do much to reduce the number of grasshoppers.

### REMEDIES.

The remedies that have been devised in the various parts of the country are not adapted to the conditions we find on the grasshopper-ridden ranges of Montana. They apply much better to the agricultural fields of the middle west states, but some of them may be used effectively in the agricultural valleys of this state. We give below a few remarks regarding the most important remedies that are known, leaving the farmer to select for himself the one most suitable for his conditions.

**Ploughing.**—Late fall or early spring ploughing is the best of all artificial remedies. It is practiced for the purpose of destroying the eggs and it follows that the eggs must first be located. In our remarks regarding the habits of grasshoppers we have called attention to the fact that in the breeding season the grasshoppers accumulate in more or less restricted areas and that the eggs are laid in

these areas. The observant farmer will locate these patches and by ploughing deeply will place the eggs so far under the soil that when the young hatch they will be unable to reach the surface. Even the young hoppers, when very small, may be turned under in the same manner.

Where ploughing cannot be resorted to, a thorough harrowing, especially with a disc harrow, will result in the destruction of a large number of the eggs by crushing some and exposing others to their numerous enemies and to frosts.

**Burning.**—When the grasshoppers are young and travel slowly they may be killed on or near the locality where they hatch by covering them with a thin layer of straw and then burning it.

In some sections of the west where crude petroleum can be obtained at small cost it is sometimes employed in the form of a spray as a remedy against young hoppers. This oil kills by contact but additional effectiveness can be secured by setting fire to the oil on the ground.

**Bandages.**—Some property owners in Montana have suffered injury to their fruit trees by grasshoppers. The young may be prevented from climbing the trees by bandaging the trunks with cotton batting, axel grease or some other adhesive substance. As the grasshoppers acquire wings they may fly into the trees and in such cases relief may be secured by the use of poisonous sprays.

**Hopper-dozers.**—Hopper-dozers are metallic pans of any convenient dimensions which are partly filled with kerosene oil and drawn about over the field for the purpose of catching the partly grown grasshoppers. Many of the insects after hopping into the

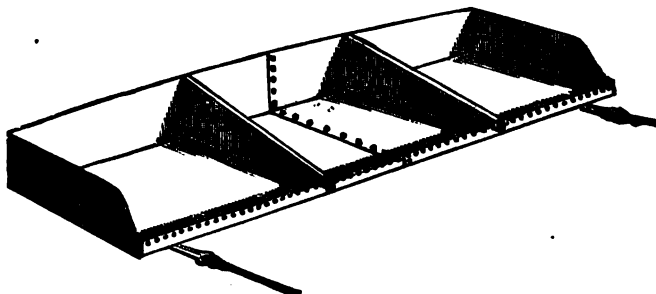


Fig. 10 Hopper-dozer, after Riley.

pans and getting covered with oil jump out again but these are invariably killed. The back of the pan is extended vertically by means of a strip of cloth or canvas supported by upright stakes. See Figure 10. In large fields several hopper-dozers are sometimes attached in series by means of a long pole and drawn by two horses, one at each end of the pole. Two horses attached in this way are much better than one in the middle of the pole because they tend to gather in the grasshoppers rather than drive them away.

**The Artificial Use of Diseases.**—Under such conditions as occur on the Montana ranges, where the greater part of the injury by grasshoppers has been done, the artificial use of deadly diseases is an attractive subject. If we were able to propagate and distribute a disease which would be communicated from one insect to another and so extended over large areas, the solution of the grasshopper problem would be reached. Various experimenters in the United States have made careful tests of such diseases but thus far very few encouraging results have been secured.

Realizing that the artificial use of diseases, though offering small hope of success, constituted the only hope, the Experiment Station through this department made a careful test of what has been called the South African grasshopper fungus disease. A single tube of this disease from Africa was very kindly given me by Prof. C. P. Gillette of Fort Collins, Colorado. Cultures on potato were made and distributed to about 300 applicants in the state. We also made careful laboratory tests on caged grasshoppers of various species, but so far as we are informed not one grasshopper was killed either in the field or laboratory test. The various other entomologists also failed to get results of decided value. We feel, therefore, that until something entirely new in the form of a disease is known, we will still have to wait for Nature to take her course, except where it is possible, in restricted areas, to use some of the other remedies.

#### CRIDDEL MIXTURE.

The substance known by this name has lately come into favor as a grasshopper remedy in some parts of the United States. It was first brought to public attention by Dr. James Fletcher, government entomologist of Canada, who, at the meeting of official entomo-

logists at Washington, D. C., 1903, stated that it had entirely replaced the cumbersome and inadequate hopper-dozer. It is made as follows: Take one part of Paris green, two parts of salt and 40 parts of horse manure by measure. Add sufficient water to make the mass soft without being fluid. Distribute through the field to be protected in quantity proportioned by the number of hoppers.

The material may be scattered from a wagon and because of its cheapness may be used sparingly over fairly extensive areas. We recommend that it be given a very thorough test around the edges of grain fields and other crops that may be threatened. We know of no remedy to recommend for use on the the ranges.

## THE COMMON TOAD\*

It is the purpose of this paper to call attention to the value of the toad to the fruit-grower, the gardener and farmer, to outline its habits and life history and to urge that it be protected against destruction by thoughtless boys.

At first thought an account of the toad may seem out of place in a report of insect life. It is entered, however, on account of my firm belief in its great economic value as a destroyer of terrestrial insects, a large number of which are injurious to the interests of man.

As will be noted, I have freely consulted and often quoted Mr. A. H. Kirkland's paper that treats of this animal, published as a bulletin of the Massachusetts Experiment Station. His paper is the most valuable that has been published on this subject.

### FALSE IDEAS CONCERNING THE TOAD.

Since before the beginning of the Christian area students have observed toads and written of their habits. Too frequently, however, actual facts and superstitions have been confounded, with the result that the early literature on this interesting and valuable batrachian is a queer medley of fact and fiction.

For the sake of brevity we will pass over this topic very briefly and omitting an account of the venomous character and medicinal

\**Bufo boreas*

virtue, as well as many other equally ludicrous qualities attributed by the ancients of Europe to this harmless and humble animal, will touch upon certain beliefs that are now current in this country.

Perhaps the creation of the imagination that is given more credulity than any other, is, that to touch a toad will cause warts on the hand. Other beliefs that have been held in this country, (we hesitate to say that any of them are now held) are, that to kill a toad will produce bloody milk in cows; that a toad's breath will cause convulsions in children; that a toad in a newly dug well will insure a good and unfailing supply of water; and that a toad in a new made cellar will bring prosperity to the household.

No less absurd than the above are the statements that we often see in the papers to the effect that some particular section has been visited by toads that fell in a recent storm in such numbers as to be very abundant in the roads, on the sidewalks and over the entire surface of the ground. While it may not be an entire impossibility for a toad to be picked up by a tornado or cyclone, no one would accredit such an atmospheric condition with the power of selecting toads from among the other equally movable objects, or if other objects were taken into the upper air along with toads we might rationally predict that both classes of objects would be deposited in the same places.

The explanation of the occurrence of toads in noticeable numbers is usually to be found in the fact that they have either hatched and grown to a sufficient size for migration in some nearby swamp or pond, or that adult toads are on their way to or from such nearby breeding places. It is well known that toads during the sunny hours of the day seek protection under stones, boards, bridges, in dense vegetation or in the soft earth—in other words, moist, cool locations. For a short time after a storm, when the air is cool and the earth and vegetation are wet, the toads are known to venture forth even at midday as they do in the cool twilight hours of the evening and morning.

### LIFE HISTORY AND HABITS.

The toad in common with other batrachians, and like reptiles, spends the winter months in hibernation. In the early spring, when

the earth has become warmed, the toad emerges from its winter quarters, and, during the warm hours of the day, makes its way to some pool or stagnant water where it meets others of its kind. A little later, their shrill cry, the mating call, may be heard. The eggs of the toad and those of the frog may both be found in the same pool, the former in long slimy strings, the latter in irregular masses. In about four weeks the eggs hatch and the tadpoles, which at first are very small and very numerous, feed on the vegetable detritus and slime which are found on the bottom of the pond and attached to weeds, sticks, etc.

The tadpole has become full grown and has transformed to a very small toad by about the first of August, in this climate. The young toads leave the pond and scatter in all directions, keeping out of sight because of their sensitiveness to heat except after showers when the earth is cool and damp.

Kirkland states that he removed 1279 ova from one average-sized female which had already commenced laying. This statement indicates great powers of multiplication in this animal. We have observed, however, that a large proportion of the tadpoles never mature into toads.

For hibernating quarters the toad makes use of cavities under rocks, in cellars, in rubbish heaps, etc.

Both in summer and in winter the temperature of the amphibian and reptilian body is about that of the surrounding air or water. When the surrounding medium goes below certain temperatures, the animal becomes torpid, stiff and may even freeze without injury. If brought into a warm room such an animal soon becomes active as in the summer only to return to the same stupor when returned to the cold. That the physiological state of hibernation is not dependent alone on a fall in temperature is shown by the fact that the many animals go into hibernation long before the approach of cold weather and, further, by the fact that other animals hibernate in warm weather during the period that their appropriate food is scarce. Some animals, moreover, are not aroused from their hibernating torpor by being brought into a warm atmosphere.

When roughly handled, the toad secretes from the wart-like projections on the back a milky fluid of a most offensive odor. That

this secretion is not objectionable to all animals is shown by the fact that hawks, owls, etc., include toads in their fare.

### LENGTH OF LIFE OF THE TOAD.

European literature gives authentic record of a toad that lived 36 years and was then killed by accident. Kirkland, in his paper already referred to, records the results of his inquiry into this interesting matter in the following words:

"Nearly every old New England homestead has one or more semi-domesticated toads whose age can only be conjectured. The writer has sought different parts of the state (Massachusetts) among families who have long resided on the places they now occupy, for some accurate information on this subject, and from a mass of statements, given in many cases with strong corroboratory details, there may be taken apparently veracious records of two toads that have occupied dooryards in two different towns for twelve and twenty-three years respectively. The histories of these toads have been given me by people of unquestionable veracity, yet I hesitate to present the records as facts, since from the evidence offered I cannot feel positive that the identity of the toad in either case has remained unchanged. There can be but little doubt that toads live to a considerably greater age than is supposed and we may hazard the opinion that many of them reach an age of at least ten or fifteen years."

### FEEDING HABITS.

Particularly in the dry climate of Montana, toads are seldom seen during the sun-lit hours of the day. That they occur here, however, is known to all observing people. In the spring of the year they may be found in large numbers in ponds and pools.

The toad takes only living, moving animal life as food. Dead food is rejected. Motionless living food is likewise rejected as has been observed by the writer and other authors. Insects that "play possum" and remain motionless are not taken by the toad.

Unlike the tongue of most other vertebrates that possess this organ, that of the toad is attached only at the anterior end where it is fastened to the floor of the mouth. It is coated with an adhesive substance that causes insects to adhere when touched by it. By a

very quick motion the tongue leaves the mouth, touches and picks up the food, and returns. So quick is the motion that the eye can scarcely follow it.

While out on their foraging expeditions these animals show interesting traits. Mr. Kirkland observed eight good-sized toads seated under an arc light engaged in picking up insects, which, deprived of their wings, fell from the lamp above. A physician in Malden, Dr. Charles Burleigh, observed that a colony of some half dozen toads made their abode under his piazza, and each summer night about eight o'clock went forth down the walk and into the street where they stationed themselves under an arc light. Here they fed upon the insects that fell from the lamp until the electric current was turned off when they returned to their accustomed shelter. From his observations, Mr. Kirkland concluded that under ordinary conditions toads feed continuously throughout the night except where food is abundant. He observed that in twenty-four hours the food consumed was equal to four times the stomach capacity.

It would be interesting to follow in detail the results of Mr. Kirkland's examination of the stomach contents of 149 toads but we must abbreviate and summarize.

Various investigators have shown, and it is a matter of common observation, that the toad takes pretty much any living animal food that crosses its path, provided it is not too large to be swallowed whole. It follows then that in various parts of the country the diet of the toad will be determined largely by what are the common insects found on the ground and low-growing vegetation, where the toad can reach them. The following table by Mr. Kirkland shows the results of the examination of 149 stomachs contents, in Massachusetts. Were such a study to be made in Montana the general character of the food would be the same but in detail it would be very different.

Unidentified material .....	5 per cent.	..
Gravel .....	1 per cent.	
Vegetable detritus .....	1 per cent.	
Worms .....	1 per cent.	
Snails .....	1 per cent.	

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Sow-bugs .....	2 per cent.
Myriapods .....	10 per cent.
Spiders .....	2 per cent.
Grasshoppers and crickets .....	3 per cent.
Ants .....	19 per cent.
Carabids .....	8 per cent.
Scarabaeids .....	6 per cent.
Click beetles .....	5 per cent.
Weevils .....	5 per cent.
Chrysomelids .....	1 per cent.
Carion beetles .....	1 per cent.
Miscellaneous beetles .....	1 per cent.
Total beetles .....	27 per cent.
Cut worms .....	16 per cent.
Tent Caterpillars .....	9 per cent.
Miscellaneous larvae .....	3 per cent.
Total cut worms, caterpillars, etc.	28 per cent.

The gravel and vegetable detritus were doubtless taken by accident in the rapid stroke of the tongue with which the food is taken into the mouth. It may, however, be of some value in grinding up the food, though it is not always found in the stomach. Of the total food 98 per cent is animal and by far the greater part of this is insect life.

In this brief account we will not discuss each of the items in the above table, but we would call attention to the large proportion of grasshoppers, ants, scarabaeids, click-beetles, weevils, chrysomelids, cut-worms, tent caterpillars, and miscellaneous larvae all of which are for the most part injurious.

### THE AMOUNT OF FOOD THE TOAD EATS.

When in the presence of abundance of food the toad eats a very large amount. Mr. F. H. Mosher of Massachusetts fed between thirty and thirty-five full grown celery worms to one toad in three hours time. Mr. J. E. Wilcox, an employe of the Gypsy Moth Committee of the Massachusetts State Board of Agriculture, before that committee was abolished and its work abandoned, fed to a toad of medium size twenty-four fourth molt gypsy moth larvae, all of

which were swallowed in less than ten minutes. Mr. Kirkland found in a single stomach the remains of twenty-seven myriapods, in another fifty-five army worms, in another sixty-five gypsy moth caterpillars and in another thirty-seven tent caterpillars.

It is not possible to make even an approximate estimate of the financial equivalent of the saving to crops brought about by the toad, but the foregoing facts are enough to remove any shadow of doubt that this humble animal is of great value to the gardiner, florist, fruit-grower and general agriculturist.

#### THE TOAD SHOULD BE PROTECTED AND FAVORED

The wanton destruction of toads by ubiquitous boys is known to all. It is not an uncommon thing for a party of boys to organize an expedition to nearby ponds for the express purpose of killing toads. Dr. C. F. Dodge, published in the Worcester (Mass.) Evening Gazette, March 31, 1897, an account of finding in a single day two hundred dead or wounded toads on the shores of a pond on the grounds of Clark University.

We should not blame the boys alone for this, the parents and school authorities are in a measure responsible for this worse than useless taking of life. Rightly trained and directed the boy can get more real pleasure, and at the same time a pleasure that is infinitely better for him, by observing the habits of toads and other animals.

The toad is as deserving of protection by legislation as are insectivorous birds. The asthetic, to be sure, is lacking, but the asthetic side of the question is not the one that prompts us to enact laws that make it a misdemeanor to kill birds. It is the economic, and on an economic basis the toad is as deserving as almost any bird.

## A MANUAL OF FRUIT PESTS WITH REMEDIES.

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In this manual we purpose to present in condensed and easily accessible form the most essential information regarding the more important insects and fungus diseases that have been recognized in the state or which are liable to appear at any time. It is our intention at an early date to prepare another manual similar to this but dealing with farm, garden and lawn pests.

The reader should freely consult the index in seeking the information he desires. All insecticides and fungicides recommended are discussed at the end of this section, and formulae for their preparation are given.

Unless the fruit-grower is confident that he knows the pest he is dealing with he should send examples to the Experiment Station for identification.

### INSECTS INJURIOUS TO THE APPLE.

#### 1, The Red-humped Apple Tree Caterpillar.

Bright colored caterpillars with a red hump on the back, feeding on the foliage of apple. Seldom very abundant.

Remedy.—Remove by hand or spray with an arsenical poison.

#### 2, Tent Caterpillars.

Hairy caterpillars with a bright bluish stripe down the middle of the back. Living on wild and cultivated cherry and on apple in the spring of the year. They construct tents or nests in the crotches of limbs from which they venture and feed during the middle of the day.

Remedy.—Remove the tent by hand, taking care to do so when the caterpillars are home. Under some conditions it is feasible to locate and destroy their eggs during the winter. The eggs appear as thickened bands on small twigs. Individual eggs are cylindrical and in the cluster are placed on end, side by side.

### 3, The Bud Moth.

Brownish caterpillars with black heads, feeding in the opening buds of apple, pear, blackberry, raspberry, and other plants in the spring of the year. Sometimes very injurious to apple, destroying the fruit buds, and by eating out the terminal-growing shoots, causing a bushy appearance of the side buds and giving the tree an unnatural appearance.

Remedy.—Keep the buds coated with an arsenical poison in the spring of the year.

### 4, Canker Worms.

Not yet found in Montana. Appearing soon after the foliage is expanded in the spring. Rapidly devouring the foliage or turning it brown. Whole orchards may be seen to be of a brown color at a distance, as a result of the attacks of this insect. When an infested limb is jarred the slender caterpillars, about three-fourths of an inch long let themselves down by silken threads.

Remedy.—Spray promptly and thoroughly with an arsenical poison as soon as their presence is first detected. In regions where they are suspected to be present it is well to keep the trees banded with building paper and smeared with an adhesive substance which may be watched in the spring of the year for the purpose of learning whether or not the wingless moths are ascending the trees to lay their eggs. A large proportion of the damage may be averted by the use of such bands. "Bodlime," sold by the Bowker Insecticide Co., Boston and Cincinnati, is a good adhesive substance to use for this purpose. Tar or printer's ink may be used but are less satisfactory.

### 5, The Codling Moth.

The larva is known as the apple worm and infests a number of fruits, but is most injurious to apple and pear. It is probably the most important pest with which the Montana fruit-grower has to deal.

Remedy.—Spray with Paris green, arsenate of lead or arsenite of lime after the petals have fallen, again two weeks later, again the first week in August. If it is not yet in your orchard, watch for its appearance by searching for wormy fruit among the wind-falls

and when harvesting the crop, and if the pest is found, begin spraying the next season. Do not bring to your orchards second-hand boxes from fruit dealers in town; it is against the laws of the state and you are liable to prosecution. Such a practice will almost surely result in the establishment of the pest in your orchard.

#### **6, The Web-worm.**

Colonies of hairy caterpillars living in tents on fruit and shade trees in the latter part of the summer and early fall. Affected limbs are enclosed in nets and the leaves are brown.

Remedy.—Remove the caterpillars by hand.

#### **7, The Flat-Headed Apple-tree Borer.**

Fairly common on apple trees in western Montana. Preferably attacks diseased or weakened trees and feeds in the larval stage in the trunk and larger branches, excavating irregular cavities under the bark and later boring into the deeper parts of the tree. It may often be detected by sunken or discolored patches in the bark.

Remedy.—Not an easy insect to combat. Practice clean culture. Dig up and burn worthless trees that are infested. In some cases it is advisable to locate the burrow of the borer and dig out the grub by means of a sharp knife or wire or other suitable instruments, taking care not to injure the tree more than necessary. Use deterrent washes.

#### **8, The Round Headed Apple-tree Borer.**

Large, legless borers in the trunks of apple trees near the ground. The anterior end of the body is of about the same diameter as the posterior part.

Remedy.—Treat as for flat-headed borer.

#### **9, Apple Twig-borer.**

Small, cylindrical, mahogany-colored beetles about one-third of an inch long, boring holes in twigs of apple, pear, cherry and other trees and in grape vines.

Remedy.—Prune off and burn infested stems.

#### **10, Leaf-hoppers.**

Small soft-bodied insects with sucking mouth parts, on the under side of the foliage of apple and other fruits. Another species is known on pear, still another on rose.

Remedy.—Spray the under side of the foliage with kerosene emulsion early in the season before the insects acquire wings and are able to fly.

#### **11, Buffalo Tree-hopper.**

Greenish or brownish three-cornered insects which make longitudinal slits in the bark of apple, laying their eggs in the slits.

Remedy.—Prune off and burn affected twigs, practice clean culture, keeping out all weeds and unnecessary vegetation.

#### **12, Woolly Aphis of the Apple.**

May be detected by the whitish woolly masses on the watersprouts at the base of the tree and on old scars on the trunk and limbs. The colony masses are made up of the bodies of the lice and cottony secretion produced by them. The most injurious form of the insect feeds on the roots of the trees.

Remedy.—For the areal form use strong kerosene emulsion early in the season. For the root form dig away the earth down to the roots and soak with hot water and return what has been removed.

#### **13, The Apple Leaf-aphis.**

Dark-green lice on the leaves of apple, causing them to curl. Common throughout the state. More abundant on young trees.

Remedy.—When only a few terminal branches are affected, dip the affected parts into a pail of kerosene emulsion. One part in nine of water, or whale-oil soap solution, one pound in eight gallons of water. Early in the season it is well to single out individual affected trees and spray with one of the above solutions.

#### **14, The San Jose Scale.**

An insect which has caused great destruction in the United States but which would probably be much less injurious in Montana. Minute circular scales on the bark of practically all our common fruit and shade trees. When abundant, giving the trees the appearance of being coated with a layer of ashes.

Remedy.—Spray with lime, sulphur wash when trees are dormant.

#### **15, The Oyster-shell Bark-louse.**

Brownish scale insects, one-twelfth of an inch long, elongated

in form, occurring on various plants but mostly on apple, on which it is most abundant at the ends of the twigs.

Remedy.—Watch for the exceedingly minute whitish larvae early in June and when they appear spray with kerosene emulsion, one part in nine of water. Repeat in a few days if more larvae are seen.

#### 16, Putnam's Scale Insect.

This insect occurs sparingly in western Montana. Resembles the San Jose scale, being a degraded form of life that lives under a very inconspicuous scale closely adhering to the bark.

Remedy.—If necessary to treat for this, wash with strong whale oil soap solution while the trees are dormant.

#### 17, The Scurfy Bark-louse.

A white scale insect on the bark of apple, pear, currant and other rosaceous plants.

Remedy.—Watch for the young to hatch early in June and spray with kerosene emulsion, one part in nine of water. If necessary spray again ten days later.

#### 18, Mealy Bug on Apple and Pear.\*

Occurs in the vicinity of Missoula. White cottony or mealy masses around the buds in the spring. Found in the winter under the scales of bark. Has been reported as injurious to young trees.

Remedy.—Use whale-oil soap or kerosene emulsion as strong as the trees will stand. In the winter search for and destroy the cottony masses on the trunks of the trees, using whale-oil soap as a wash.

#### 19, Ants as Fruit Pests.

We have received reports of ants as being injurious to young fruit trees, building their mounds at the bases of the trees and eating off the bark and girdling the trunk. We have also known ants to be injurious to apple trees by gnawing the buds in the spring of the year.

Remedy.—Pour bi-sulphide of carbon into the colonial mounds; from one to five or six tablespoonfuls should be enough. This substance must not be put close to the trunks of apple trees.

\**Phenacoccus* sp.

### 20, Grasshoppers.

Young grasshoppers sometimes crawl up the trunks of trees and devour the foliage. Later when they acquire wings they fly into the trees.

Remedy.—Spray the foliage heavily with arsenate of lead. To prevent the young from ascending the trees; tie belts of cotton about the trunk or smear printer's ink or some other adhesive material on a band of paper on the trunk.

### 21, The Clover Mite.

Giving the leaves of apple and other trees a whitish devitalized appearance. In the fall of the year and during the winter masses of very minute reddish eggs may be found on the trees, particularly in the crotches. The mites sometimes become annoying on lawns and in dwellings by crawling through the windows.

Remedy.—Spray affected trees with the 1-1-4 formula of lime-sulphur wash in the fall or early spring, while the trees are bare of leaves. Spray with kerosene emulsion to destroy the pest in the vicinity of the house.

## INSECTS INJURIOUS TO THE PEAR.

### 22, The Pear-leaf Blister-mite.

Generally distributed in Western Montana. Causing thickened reddish spots and blotches on the leaves of pear; later in the season the spots die and turn brown, sometimes causing the foliage to drop prematurely. Serious on individual trees but does not spread very rapidly.

Remedy.—To prevent spreading, gather and burn the fallen leaves from invested trees. Spray in the spring before the buds open with the 1-1-4 lime-sulphur wash.

### 23, The Pear Slug.

Injurious to the leaves of pear, plum and cherry. Slimy slugs on the upper side of the leaves, eating off the surface parts, leaving the under surface and the network of veins, which later turn brown, giving the parts of the tree affected a brownish appearance.

Remedy.—Spray with arsenical poisons or dust or spray with hellebore.

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**INSECTS INJURIOUS TO CHERRIES.****24, The Cherry Aphis.**

A dark colored aphis on the under side of the leaves of cherry. Common in western Montana. Occuring throughout the state.

Remedy.—Treat as for apple-leaf aphis.

**INSECTS INJURIOUS TO THE PEACH.****25, The Peach Tree Borer.**

Primarily a peach pest, but attacking also cherry, prunes and plum. Boring in the trunks near the ground, causing characteristic gummy masses to exude on peach trees. The injury is most apparent in the spring.

Remedy.—A difficult pest to control. Keep the trees well fed and in a healthy growing condition. Prof. Slingerland has recommended the use of gas-tar smeared on the trunks to prevent the moths from depositing their eggs, and in combination with this the digging out method to destroy such larvae as gain access to the trees.

**26, The Peach Twig Borer.**

Though not yet found in Montana, it may turn up at any time. Reddish pink caterpillars boring in the young tender twigs of peach, plum and prune in the early spring, later feeding in the fruit near the pit.

Spray with strong kerosene emulsion in the winter. The oil destroys the worms by penetrating into the holes.

**INSECTS INJURIOUS TO PLUMS AND PRUNES.****27, Plum Gouger.**

Small beetles, about a quarter of an inch in length, of a leaden gray color with a yellowish head and thorax, eating pinholes in growing plums. The larva of grub feeds in the pit, later eating its way out through the pit and flesh of the plum just as the fruit matures. Attacks only American varieties.

Remedy.—Jar the trees early in the morning or in the evening when the trees are in bloom and the fruit is setting, catching the beetles that drop on a sheet spread underneath. A few beetles are able to do a great damage. Prof. Gillette found that a single female

lays as many as 450 eggs. Gather and destroy all the stung plums before the grubs escape. Spray heavily with arsenate of lead before the blossoms are out.

### **28, The Plum Curculio.**

The beetles make a crescent-shaped slit on the fruit of the plum. The larva feeds in the young fruit causing it to drop. Said to be in the Bitter Root valley.

Remedy.—Spray thoroughly with arsenical insecticides before the leaves open. Jar the trees in the early morning catching the beetles on canvas or a sheet and destroying them by burning or crushing. Promptly gather and destroy fallen fruit.

### **29, Plum Aphis.**

Numerous pale-green lice on tender shoots of plum. Common in Montana, sometimes injurious.

Remedy.—Treat as for apple aphis, but use extra precaution as the plum foliage is much more liable to be injured by insecticides.

### **30, The Box Elder Plant-bug.**

Sometimes very injurious to foliage and fruit of plum and prunes. Feeds primarily on box elder. Red and black bugs with a long, jointed snout

Remedy.—Spray with kerosene emulsion to kill the young insects. It is sometimes necessary to remove neighboring box elder trees for the sake of doing away with the breeding place of the insects.

## **INSECTS INJURIOUS TO THE STRAWBERRY.**

### **31, The Strawberry Leaf-roller.**

Generally distributed in Montana, and at times a destructive species. Feeds on strawberry, blackberry, raspberry and other plants. Rolls or crumples the foliage. Larvae small, greenish in color.

Remedy.—After harvesting the crop, mow the vines, leaving them to dry. Then burn them. If there are enough vines to burn well first put some hay or straw over the field. If preferred vines may be sprayed with arsenate of lead after harvesting the fruit.

### **32, The Tarnished Plant-bug.**

Common throughout the state. Native to Montana, feeding on many wild plants. About one-fourth of an inch in length, variable

in color, but usually marked with yellow, black and brown. Flies when disturbed. Most injurious in the spring of the year when they attack tender shoots and opening buds. Most commonly known in Montana as an enemy to blossoms and young fruit or strawberry and to young trees in the nursery row.

Remedy.—It is not always easy to control this insect. When found on young fruit trees, jar them off in the cool of the day into some receptacle which contains kerosene oil.

### 33. Strawberry Root Weevil.\*

Small hard beetles with an elongated snout which feed on the foliage of strawberries in the early summer. The larvae feed on the roots and are very injurious.

Remedy.—Delay the planting of the new crop until the beetles have deposited their eggs. Keep the foliage coated with arsenate of lead in the early part of the summer.

### 34. Strawberry Crown Borer.

Small yellowish white grubs boring in the crown of plants during the summer. A species which though not yet recognized in Montana is liable to be introduced at any time on imported plants.

Remedy.—In a field that is known to be infested do not allow the plants to become very old but start a new bed at some distance from the old one; burn over the patch as for the strawberry leaf-roller.

## INSECTS INJURIOUS TO CURRANTS AND GOOSEBERRIES.

### 35. Native Currant Saw-fly.

Pale-green larvae which appear in the latter part of June or early in July and very rapidly devour the foliage of gooseberry and currant bushes. The second brood appears about three weeks later. Shows preference for gooseberry.

Remedy.—Dust the bushes with powdered hellebore or spray at the rate of one pound to a gallon of water. Be prompt in the treatment and do not allow them to defoliate the bushes.

### 36. Currant Flies.

Maggots feeding the fruit of the currant, causing here and there

\**Otiorhynchus ovatus* Linn.

a berry to turn red prematurely; in severe cases causing the entire crop to fall to the ground.

Remedy.—Either gather the fallen fruit frequently and destroy it, or, after all of the insects have dropped to the ground, turn with a plow a deep furrow of earth against the row, then with a rake or shovel smooth the earth down around the bushes so as to cover up the hibernating insects so deeply that they cannot escape. This should be done in the fall or early spring.

### **37, The Currant Stem Borer.**

Larvae of a clear-winged moth, a near relative of the peach borer, which makes burrows in the currant canes, sometimes becoming very injurious.

Remedy.—Watch the currant bushes in the early part of the summer about the time the fruit is setting and cut out and burn affected canes which may be detected by the yellowish color or wilted condition of the foliage.

### **38, Currant Leaf-hopper.**

Minute whitish insects on the under side of foliage of currant in the early part of the season. Later they acquire wings and have pinkish markings.

Remedy.—Spray the under side of the foliage with kerosene emulsion, one part in nine of water in the early part of the season.

### **39, The Currant Aphis.**

Green lice on the under side of currant leaves, causing the leaves to turn reddish in color and to have an irregular surface.

Remedy.—Spray with kerosene emulsion or whale-oil soap solution. This spray kills only by coming in contact with the lice, therefore direct it against the under side of the leaves.

### **40, Currant Thrips.**

Minute reddish insects of elongated form which cluster on the tender buds and blight them.

Remedy.—Pick off and destroy the affected parts.

### **41, Currant Cottony Scale.**

Cottony masses on the canes of currant and gooseberry.

Remedy.—Spray with whale-oil soap solution, 1 pound in 4 gallons of water during the winter. In gardens where it is possible wash off the cottony masses with a strong stream of water.

#### **42, The Gooseberry Fruit-worm.**

A near relative of the codling moth which feeds in the gooseberry fruit, causing it to prematurely turn color and later to drop off. Several berries are often bound together. Common in the fruit-growing sections of the state.

Remedy.—Carefully go over the bushes and pick off the affected berries and destroy them before the worms leave. Do this at least twice in the season.

### **FUNGUS DISEASES.**

#### **1, Black Spot, or Apple Canker.**

This is peculiarly a northwest disease and attacks only the apple. It is said to occur in western Montana. The disease is confined to the bark and produces characteristic brownish or nearly black spots. The spores are distributed during the early fall.

Remedy.—Under some circumstances relief may be secured by cutting out the affected parts. Since the disease spreads from November 1st to February 1st, it is evident that trees should be coated with a fungicide during this period. On account of frequent storms; however, it would be difficult to keep a fungicide on the trees.

#### **2, Crown Gall.**

Various plants, including apple, almond, apricot, blackberry, cherry, chesnut, English walnut, grape, peach, pear, plum, raspberry, and poplar are affected with abnormal growths on the roots which have been called crown-gall. These galls vary from a size as big as a fist or larger down to very small excrescences on the fine roots. Whether or not all of these trees are affected with the same organism is not clear. A serious trouble on apple in Montana. Irrigation seems to favor its development.

Remedy.—Do not plant affected trees. Examine the roots of all new stock and discard any that shows even the slightest sign of this disease.

#### **3, Apple Scab.**

Attacks leaves and fruit and sometimes also the twigs. Circular smoky spots on the fruit which interfere with its development. Spots begin to appear when the fruit is about half grown. They

may be as large as a dime, but are usually smaller. On the leaves the fungus appears as dark olive green spots which do not have a distinct border line and occur mostly on the upper side of the leaf.

Remedy.—Spray with Bordeaux mixture three times and ammoniacal copper carbonate (cupram) twice. First spraying of Bordeaux should be applied just before the blossom open, the second just after the petals fall, the third about ten or twelve days later. The two sprayings of cupram should follow the Bordeaux at intervals of two weeks. Bordeaux is not used in the last two sprayings since it causes the fruit to russet.

#### 4. Pear Scab.

So similar to apple scab that no separate account is necessary. Remedy.—Treat as for apple scab.

#### 5. Pear Blight or Fire Blight.

Attacking individual limbs of pear, and occasionally apple and quince also. Rapidly spreading until the whole tree may be involved. The foliage turns suddenly brown as if by fire and an examination under the bark shows a fermented condition. This disease is believed to be distributed by insects that visit the flowers, as well as by other means.

Remedy.—Cut out the disease as soon as it appears and prune again whenever necessary. Always cutting below the point where the disease is reached. It is usually best to cut at least a foot below the point where the disease appears to end.

#### 6. Gooseberry Mildew.

This troublesome disease usually appears in the spring upon the developing buds and leaves, first showing as a sparse cob-webby coating, which later develops into a denser white, powdery coating. The young berries are also attacked. A serious disease which very much interferes with the growing of choice foreign varieties.

Remedy.—Spray with potassium sulphite at the rate of one-half ounce to one gallon of water, making the first application as soon as the leaves begin to unfold, repeating the operation at intervals of one to three weeks. The ammoniacal solution of copper carbonate would probably be equally effective.

## INSECTICIDES AND FUNGICIDES.

### Arsenate of Lead.

This valuable insecticide is rapidly coming to the front as a safe and reliable arsenical poison. It can be applied to the foliage in any desired strength without injury, and when applied remains through rain storms. Its white color may be detected on the leaves thereby serving as a guide in its application. It is made by the union of acetate of lead and arsenate of soda, both being soluble in water. It is no longer necessary for the user to make his own arsenate of lead for it is now being sold at reasonable prices by the Bowker Insecticide Co., Boston, Mass., and Wm. H. Swift, Boston, Mass.

### Paris Green.

Paris green is an old, well-known arsenical insecticide. It was first brought to prominence in connection with the war that was waged against the Colorado potato-beetle in the western states between 1860 and 1870.

In spraying with this substance a hot day should be avoided if possible, especially if it is desired to apply nearly to the limit of what the foliage will stand without injury. The water on the foliage soon becomes warmed and when warm dissolves the Paris green more rapidly, thereby resulting in injury to the leaves.

### Arsenite of Lime.

The desire for a reliable and cheaper arsenical insecticide has led to the employment of a product resulting from the union of freshly slacked lime and commercial white arsenic. The proportions are:

Commercial white arsenic.....1 pound.

Unslacked lime ..... 2 pounds.

Water ..... 2 gallons.

Boil together for twenty minutes to half an hour. As soon as the arsenic is dissolved it is precipitated by the lime as insoluble arsenite of lime. There is danger however that not all the arsenic will be precipitated out as it is difficult to tell when all has been

dissolved. For this reason the following formula is considered much more reliable:

White arsenic ..... 2 pounds.  
 Sal soda ..... 4 pounds.  
 Water ..... 2 gallons.

Boil for about fifteen minutes or until all is dissolved, leaving a clear liquid. Add water enough to replace what has boiled away to prevent chrysalization of the arsenite of soda. A large quantity may be prepared at one time and kept as a stock solution to be used when desired. It should be covered to prevent evaporation and plainly labeled for it is a deadly poison. One pint of this stock is approximately equivalent to four ounces of Paris green. It should be used only in a solution in which lime is present for, as seen above, it is soluble in water. With lime it forms arsenate of lime which is the resulting product of the previous formula. It may also be used in connection with Bordeaux mixture, in which case Bordeaux mixture is used as a diluent in place of water.

Counting the cost of the preparation of arsenite of lime it is not probable it will be found cheaper unless large quantities are to be used. In using this substance in preference to Paris green, however, one avoids the danger of purchasing adulterated goods.

### Hellebore.

Hellebore has a narrow range of usefulness and is effective chiefly against saw-fly larvae. It kills by coming in contact with soft-bodied insects or by being eaten. It is usually dusted on the foliage either pure or mixed with twice its amount of lime, plaster or cheap flour. The foliage should be moist when it is applied in a dry form, otherwise it will not adhere. In Montana where the foliage is almost perpetually dry, it would be better to apply it as a spray at the rate of one ounce to 2-4 quarts of water. Hellebore is not poisonous to man.

### Kerosene Emulsion.

Pure kerosene is fatal to almost all insects. It is extremely penetrating and enters the breathing pores of the insects and interfering with their breathing causes their death. Pure kerosene, however, is more or less injurious to plant life and for this reason has to be diluted in some way. Since it will not mix with water it is necessary to form an emulsion, and soap is usually used for this purpose.

A good formula is:

Ordinary bar soap ..... ½ pound.  
 Soft water ..... 1 gallon.  
 Kerosene ..... 2 gallons.

The water is placed over a stove to heat and the soap shaved into it. When the soap is dissolved and the water has reached the boiling point the solution is poured into the kerosene and vigorously churned for four or five minutes with a force pump the nozzle of which is directed back into the vessel. The mixture takes on a milky appearance and on cooling becomes jelly-like. This is the stock emulsion and if properly prepared will keep for a considerable length of time, but should be diluted when used.

### Whale-oil Soap.

Whale-oil soap, more correctly known as fish-oil soap, is of great value as an insecticide against certain classes of insects particularly scale insects. Some species of plant lice which fail to succumb to an application of very strong kerosene emulsion are readily killed with a solution of whale-oil soap. An example is the louse so commonly attacking spruce trees in Montana causing cone-like galls on the twigs.

Ordinary foliage will not safely stand a stronger solution than one pound in four gallons of water. Most plant lice are readily killed by 1 pound in 6 gallons of water. If a good whale-oil soap cannot be obtained a substitute may be made by the following formula:

Concentrated lie .....  $3\frac{1}{2}$  pounds.

Water ..... 8 gallons.

Fish-oil ..... 1 gallon.

Dissolve the lie in boiling water and add the oil to the solution still boiling. Continue to boil for two and a half hours and then allow it to cool. The fish-oil can be obtained in eastern markets and beyond doubt it would be cheaper for the fruit-grower to make his own soap provided he intends to use a considerable quantity.

### Lime-Sulphur-Salt Solution.

This insecticide is used chiefly as a means of destroying the San Jose scale, but is of great value also as a remedy for many other pests. Though various formulae have been given for the preparation of this wash, the active caustic principle is the same in all. The caustic ingredient is produced by the union of the sulphur and lime. In part two of Bulletin 56 of the Washington Experiment Station by Prof. C. V. Piper and R. W. Thatcher it is shown by accurate chemical processes that, practically speaking, one part of lime causes two parts of sulphur to go into solution and that the presence of salt in the solution does not influence the action of the sulphur and lime upon each other. It follows then, that if a greater proportion of lime is used, the excess goes onto the tree merely in the form of a white-wash, and if the salt has any value it is purely a mechanical one, for salt in such a small proportion is valueless as an insecticide. We

are not prepared to say that there is not some benefit to be derived from the presence of the salt and the excess of lime and for the present we recommend the formulae given below. We suggest, however, that fruit-growers make more careful tests of the wash with the salt omitted and with the sulphur and lime in the proportion of 1 to 1. It will, of course, be understood that a variation in the amount of water used in the formulae will result in making the wash more or less concentrated according as more or less water is used.

The ingredients may be used in the following proportion:

Lime .....	1 pound.
Sulphur .....	1 pound.
Salt .....	½ to 1 pound.
Water .....	4 gallons.

While we recommend the addition of salt under ordinary circumstances, this substance is unnecessary in the treatment of pear-leaf blister mite, moreover, Prof. Piper found it to be unnecessary in treating for the San Jose scale.

Slake the lime thoroughly in a vessel, which is to be used in boiling the mixture, then add the sulphur; boil at least for one hour using enough water to completely cover the sulphur and lime. Add the remainder of the water of the formula.

### Hydrocyanic Acid Gas.

This very deadly gas is coming into common use as a means of destroying many forms of insect life that cannot be controlled with poisons or contact insecticides.

The gas is a deadly poison to all animal life and in its use great care must be taken not to inhale it. It is prepared by the action of sulphuric acid and potassium cyanide. The potassium cyanide, again, is a deadly poison and a small quantity taken into the stomach will result in death. Potassium cyanide may be obtained from Roesler Hasslacher & Co. of New York City.

The gas is used in different strengths for different purposes. The desired strength being obtained by taking a given quantity of the potassium cyanide and adding to it the required amount of sulphuric acid. For fumigation of nursery stock the proportions used, per each cubic foot of space inclosed are:

Potassium cyanide, 0.25 grams.

Sulphuric acid, 98 per cent.

One-half more acid, liquid measure than cyanide.

Water, one-half more water liquid measure than acid.

The following is taken from Johnson's Fumigation methods:

"The amount of cyanide necessary for any inclosure is determined in terms of grams per cubic foot of space inclosed To deter-

mine the exact amount of cyanide necessary to fumigate a room, car, ship or building of any kind: the cubic contents must be accurately computed. As an example: a room 20 x 30 x 10 feet contains 6,000 cubic feet of air space. To estimate the amount of cyanide necessary for this inclosure multiply 6,000 by 0.25; thus: 6,000 times 0.25 equals 1500 grams. To reduce this to ounces divide by 28.35 as there are 28.35 grams in an ounce; thus: 1500 divided by 28.35 equals 53 ounces, the exact amount necessary for the inclosure. It is now easy to determine the amount of acid and water; as a half more acid, liquid measure, than cyanide, and a half more water than cyanide are used; thus: 53 divided by 2 equals 26.5, which added to 53 equals 79.5 ounces of acid or practically 5 pounds liquid measure. Again 79.5 or practically 80, as we usually discard fractions, equals 40, which added to 80 makes 120 ounces of water."

In liberating the acid the gas is first measured and poured into an earthenware dish, then the water is measured and poured into the acid. The potassium cyanide which has been previously weighed is then added to the acid and water after every precautionary arrangement has been made. If a room is to be fumigated, a bag containing the potassium cyanide should be suspended directly above the jar with the string suspending it passing through a pulley. Then the operator from the door may release the string and allow the bag to settle into the jar. If the space to be fumigated is under a tent the cyanide may be dropped in from the hand. Close the door tightly or drop the tent quickly and leave the desired length of time. The room or the tent should be air-tight. The exposure usually employed is thirty to forty minutes.

Some horticulturists fumigate their green-houses a few times a year and are able by this means to keep down all injurious insects except the red spider. In fumigating mills, hotels, etc., it is necessary to have an arrangement for ventilating the rooms from the outside. This may be done by attaching cords to the window sashes. After fumigation, such buildings must be allowed to ventilate thoroughly before entering them. In fumigating buildings give an exposure of 1 hour to 24 hours.

#### **Bordeaux Mixture.**

We quote the following from Farmers' Bulletin, No. 38, U. S. Department of Agriculture, prepared by Dr. Galloway:

"All things considered, it is believed that the best results will be obtained from the use of what is known as the 50-gallon formula of this preparation. This contains:

Water .....	50 gallons.
Copper sulphate .....	6 pounds.
Unslacked lime .....	4 pounds.

It has been found that the method of combining the ingredients has an important bearing on both the chemical composition and the physical structure of the mixture. The best results have been obtained from the use of the Bordeaux mixture made in accordance with the following directions:

In a barrel or other suitable vessel, place 25 gallons of water. Weigh out 6 pounds of copper sulphate, then tie the same in a piece of coarse gunny-sack and suspend it just beneath the surface of the water. By tying the bag to a stick across the top of the barrel no further attention will be required. In another vessel slack 4 pounds of lime, using care in order to obtain a smooth paste, free from grit and small lumps. To accomplish this it is best to place the lime in an ordinary waterpail and add only a small quantity of water at first, say a quart or a quart and a half. When the lime begins to crack and crumble and the water to disappear add another quart or more, exercising care that the lime at no time gets too dry. Toward the last considerable water will be required, but if added carefully and slowly a perfectly smooth paste will be obtained, provided, of course, the lime is of good quality. When the lime is slacked, add sufficient water to the paste to bring the whole up to 25 gallons. When the copper sulphate is entirely dissolved and the lime is cool, pour the lime milk and copper sulphate solution together into a barrel holding 50 gallons. The milk of lime should be thoroughly stirred before pouring. The method described insures good mixing, but to complete this work the barrel of liquid should receive a final stirring, for at least three minutes, with a broad wooden paddle.

It is now necessary to determine whether the mixture is perfect—that is, if it will be safe to apply it to tender foliage. To accomplish this, two simple tests may be used. First insert the blade of a pen-knife in the mixture, allowing it to remain there for at least one minute. If metallic copper forms on the blade, or, in other words, if the polished surface of the steel assumes the color of copper plate, the mixture is unsafe and more lime must be added. If, on the other hand, the blade of the knife remains unchanged, it is safe to conclude that the mixture is as safe as it can be made. As an additional test, however, some of the mixture may be poured into an old plate or saucer, and while held between the eyes and the light the breath should be gently blown upon the liquid for at least half a minute. If the mixture is properly made, a thin pellicle, looking like oil on water, will begin to form on the surface of the liquid. If no pellicle forms, more lime should be added.

If spraying is to be done upon a large scale, it will be found more convenient and economical in every way to prepare what are known as stock solutions of both copper and lime. To prepare a

stock solution of copper sulphate, procure a barrel holding fifty gallons. Weigh out 100 pounds of copper sulphate and after tying it in a sack suspend it so that it will hang as near the top of the barrel as possible. Fill the barrel with water and in two or three days the copper will be dissolved. Now remove the sack and add enough water to bring the solution up again to the 50-gallon mark, previously made on the barrel. It will be understood, of course, that this second adding of water is merely to replace the space previously occupied by the sack and the crystals of copper sulphate. Each gallon of the solution thus made will contain two pounds of copper sulphate, and, under all ordinary conditions of temperature, there will be no material recrystallization, so that the stock preparation may be kept indefinitely.

Stock lime may be prepared in the same way as the copper sulphate solution. Prepare a barrel holding 50 gallons, making a mark to indicate the 50-gallon point. Weigh out 100 pounds of lime, place it in a barrel and slack it. When slacked, add sufficient water to bring the whole mass up to 50 gallons. Each gallon of this preparation contains, after thoroughly stirring, two pounds of lime.

When it is desired to make Bordeaux mixture of the 50-gallon formula it is only necessary to measure out three gallons of the stock copper solution, and, after thoroughly stirring, 2 gallons of stock lime; dilute each to 25 gallons, mix, stir, and test as already described. One test will be sufficient in this case. In other words, it will not be necessary to test each lot of Bordeaux made from the stock preparations, provided the first lot is perfect and no change is made in the quantity of the materials used. Special care should be taken to see that the lime milk is stirred thoroughly each time before applying. As a final precaution it will be well to keep both the stock copper sulphate and the stock lime tightly covered."

For trees in foliage use only 4 pounds of the blue stone to 50 gallons of water. For tender foliage like plum, cherry, and peach use 3 pounds of blue stone to 50 gallons of water (Bul. 75, Oregon Exp. Station).

#### **Ammoniacal Solution of Copper Carbonate.**

We also take this description from Farmers' Bulletin No. 38.

"This preparation as now generally used, contains:

Water ..... 45 gallons.

Strong Aqua ammonia ..... 3 pints.

Copper carbonate ..... 5 ounces.

The copper carbonate is first made into a thin paste by adding a pint and a half of water. The ammonia water is then slowly added, and if of the proper strength, i. e., 26 degrees, a clear, deep-blue

solution is obtained, which does not become cloudy when diluted to 45 gallons.

The ammoniacal solution of copper carbonate being a clear liquid its presence on the leaves, fruit, and other parts of the treated plant is not so noticeable as where preparations containing lime are used.

In case it is desired to keep the strong solution as a stock preparation, the bottle or jug in which it is placed should be tightly corked."

### Copper Sulphate.

Copper sulphate (blue vitrol or blue stone) solution is sometimes used in place of Bordeaux mixture. It is also used as a means of destroying the spores of grain smut on seed grain, but for this purpose formalin is considered to be better.

For trees in a dormant state, use copper sulphate, 1 pound in 25 gallons of water. For trees in foliage use copper sulphate, 1 pound in 250 gallons of water.

### Potassium Sulphide.

This substance, also known as liver of sulphur, may be obtained from almost any druggist. It is used in the proportion of one-half to one ounce in one gallon of water. A stock solution may be made as follows:

Potash .....	32 pounds.
Sulphur .....	37 pounds.
Salt .....	2 pounds.
Water .....	50 gallons.

The potash, sulphur and salt are put into a large, metallic tub with a part of the water; the chemical action will make the mixture boil. Add the remainder of the water and set it away as a stock solution, covering it to prevent evaporation. Dilute with 99 parts of water before spraying.

R. A. COOLEY.

## EXPLANATION OF PLATES

(Photographed from Nature by R. A. Cooley except top figure of plate II, which was loaned by Prof. Slingerland from his bulletin on the bud moth, 147, Corn. Univ. Experiment Station.)

## PLATE I.

- Fig. 1, Egg of the bud moth, greatly enlarged. .  
" 2, The 5-spotted lady-bug, enlarged.  
" 3, Cluster of eggs of the 5-spotted lady-bug.  
" 4, Same.  
" 5, Larva of the 5-spotted lady-bug, about four time enlarged.  
Fig. 6, Base of apple leaf from below showing work of bud moth larva. The web and tubular retreat are indistinctly shown.  
Fig. 7, Full grown larva of the bud moth, about three times enlarged.

## PLATE II.

- Fig. at top, Apple twig showing work done by bud moth larvae early in the season.  
Fig. 1, Apple-leaf aphid on the under side of a leaf.  
" 2, Terminal apple shoots showing leaves deformed by apple leaf-aphid.

## PLATE III.

- Fig. 1, Top view of *Sarcophaga cimbicis* Townsend, about twice natural size.  
Fig. 2, Same from side.  
" 3, Larva or maggot of same.  
" 4, Pupa of same.  
" 5, Apple leaf-aphid, enlarged.  
" 6, Eggs of apple leaf-aphid, about twice natural size.  
" 7, Root and base of trunk of young apple tree showing injury done by Flat-headed apple-tree borer.

## PLATE IV.

Lines indicate the length of the body from front of head to tip of wings or abdomen, whichever extends farther.

Fig. 1, Lesser Migratory Locust, *Melanoplus atlantis* Riley, female.

Fig. 2, Same, male.

" 3, Big-headed Grasshopper, *Aulocara elliotti* Thomas, female.

Fig. 4, Same, male.

## PLATE V.

Lines indicate the length of the body from front of head to tip of wings or abdomen whichever extends farther.

Fig. 1, Yellow-winged Locust, *Camnula pellucida* Scud, female

" 2, Same, male.

" 3, Two-striped locust, *Melanoplus bivittatus* Say, female.

" 4, Same, male.

## PLATE VI.

Lines indicate the length of the body from front of head to tip of wing or abdomen whichever extends farther.

Fig. 1, *Melanoplus dawsoni* Scudder, female.

" 2, *Hippiscus neglectus* Thomas, female.

" 3, *Chortophaga viridifasciata* DeG., female.

" 4, *Encoptolophus sordidus* Burm, female.

## PLATE VII.

Lines indicate the length of the body from front of head to tip of wings or abdomen whichever extends farther.

Fig. 1, *Spharagemon aequale* Say, female.

" 2, *Melanoplus spretus* Uhler, female.

" 3, *Arphia tenebrosa* Scudder, female.

" 4, *Acrolophitus hirtipes* Say, female.

## PLATE VIII.

Lines indicate the length of the body from front of head to tip of abdomen or wings whichever extends farther.

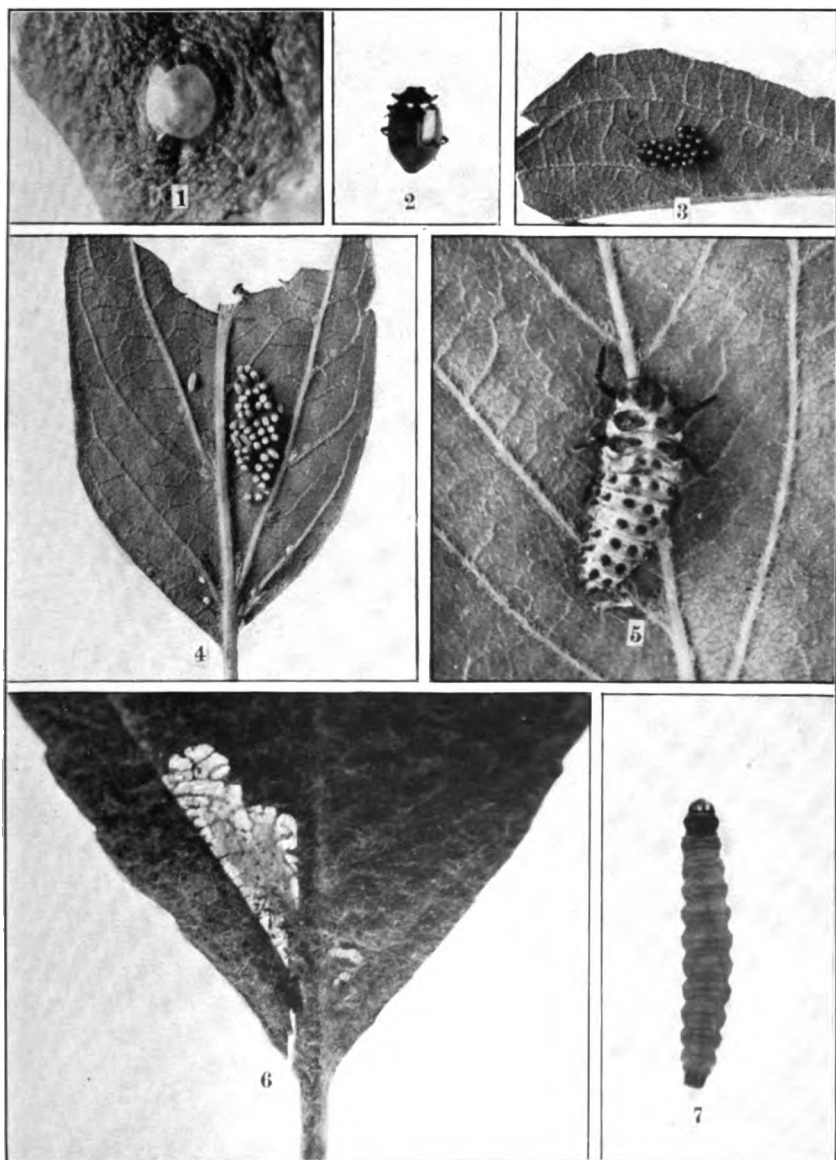
Fig. 1 *Dissosteira carolina* Linn., female.

" 2, *Cordillacris occipitalis* Thomas, female.

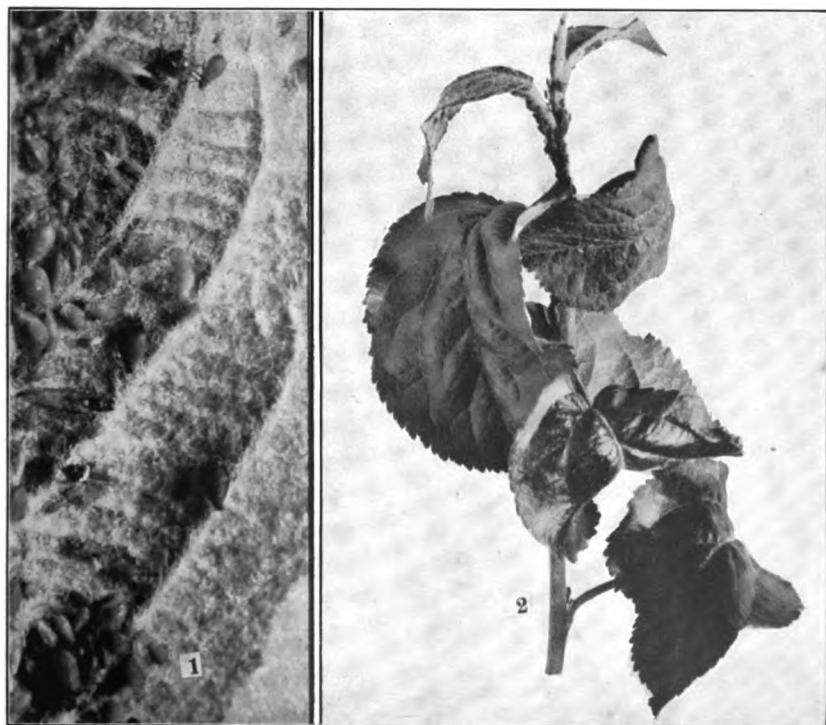
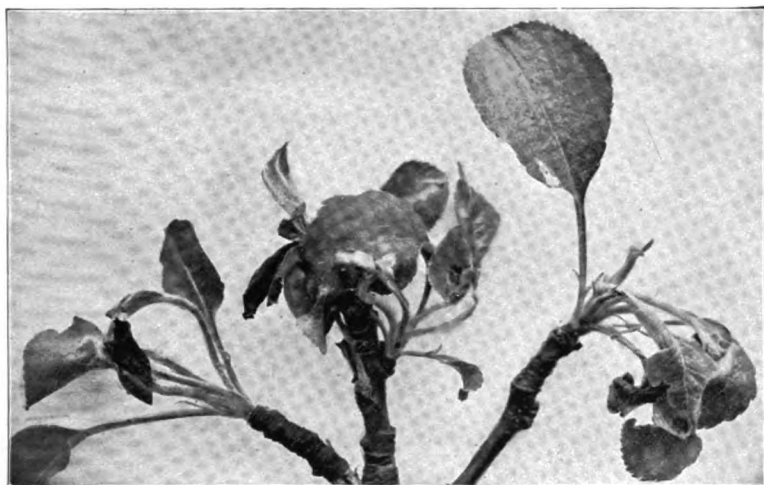
" 3, Egg mass of *M. bivittatus*, about three and one-half times natural size.

Fig. 4, Same with the surface removed.

PLATE I









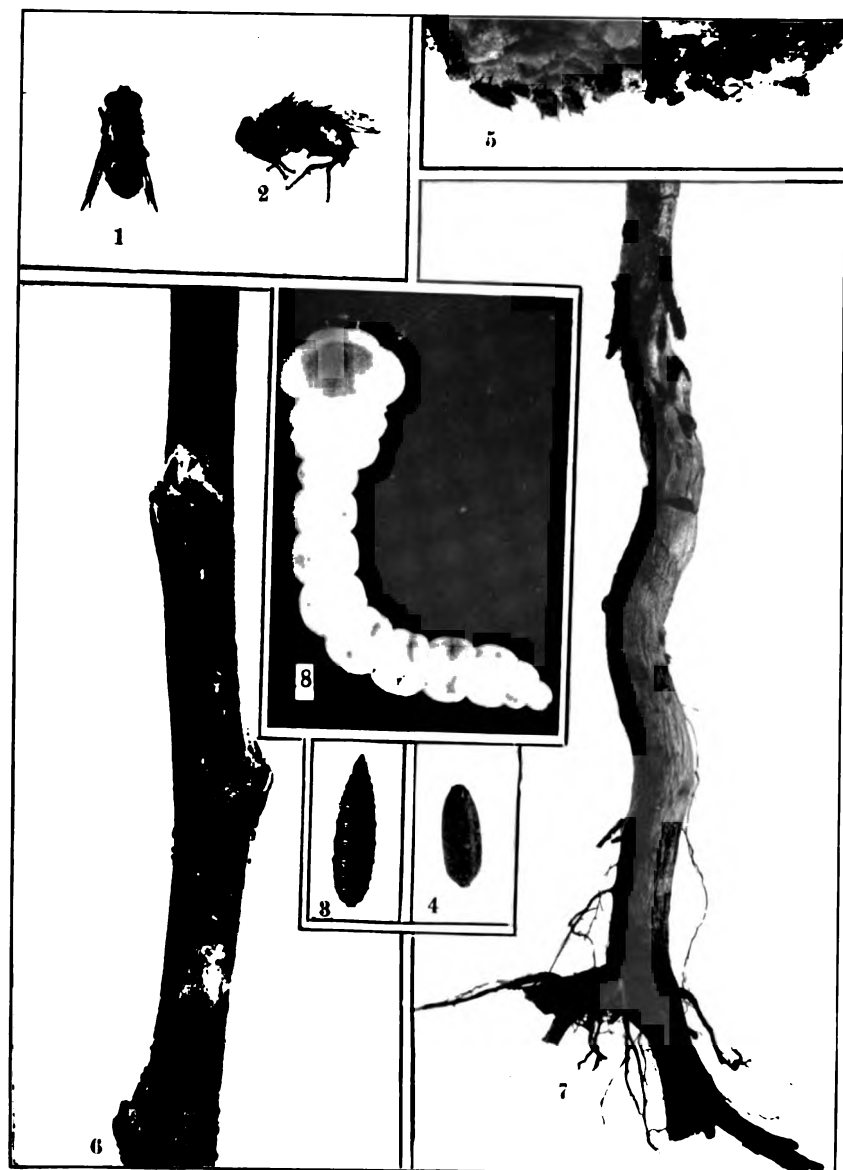
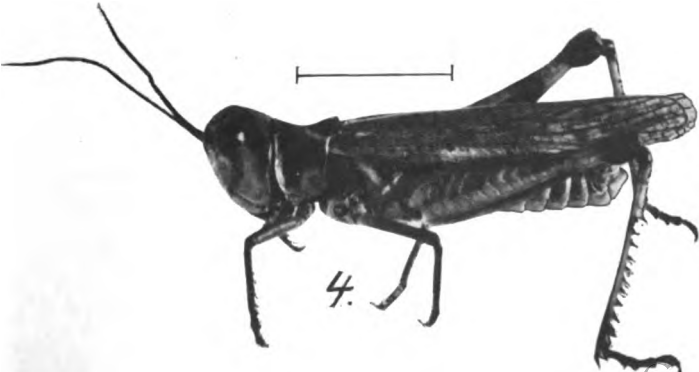
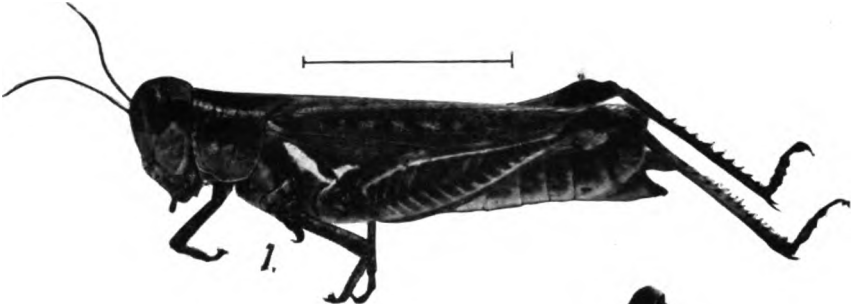
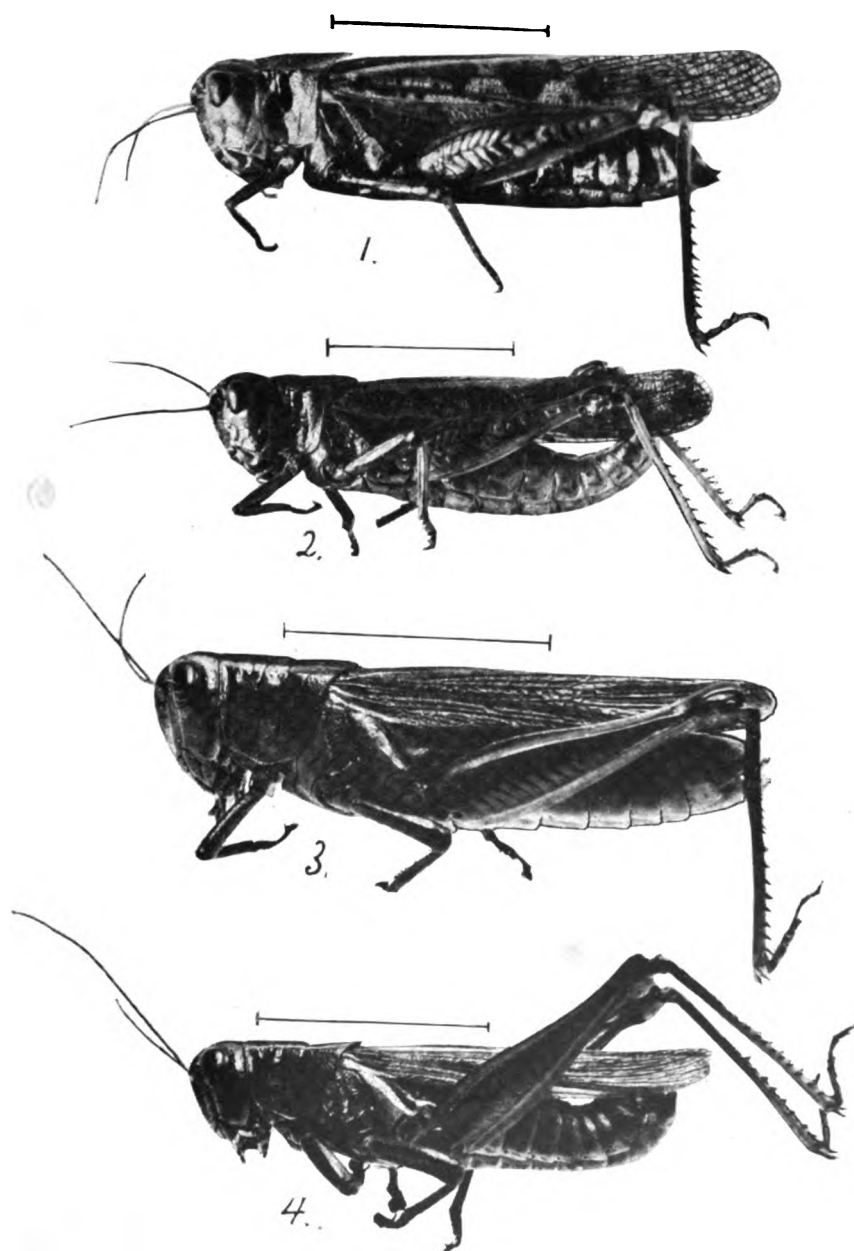




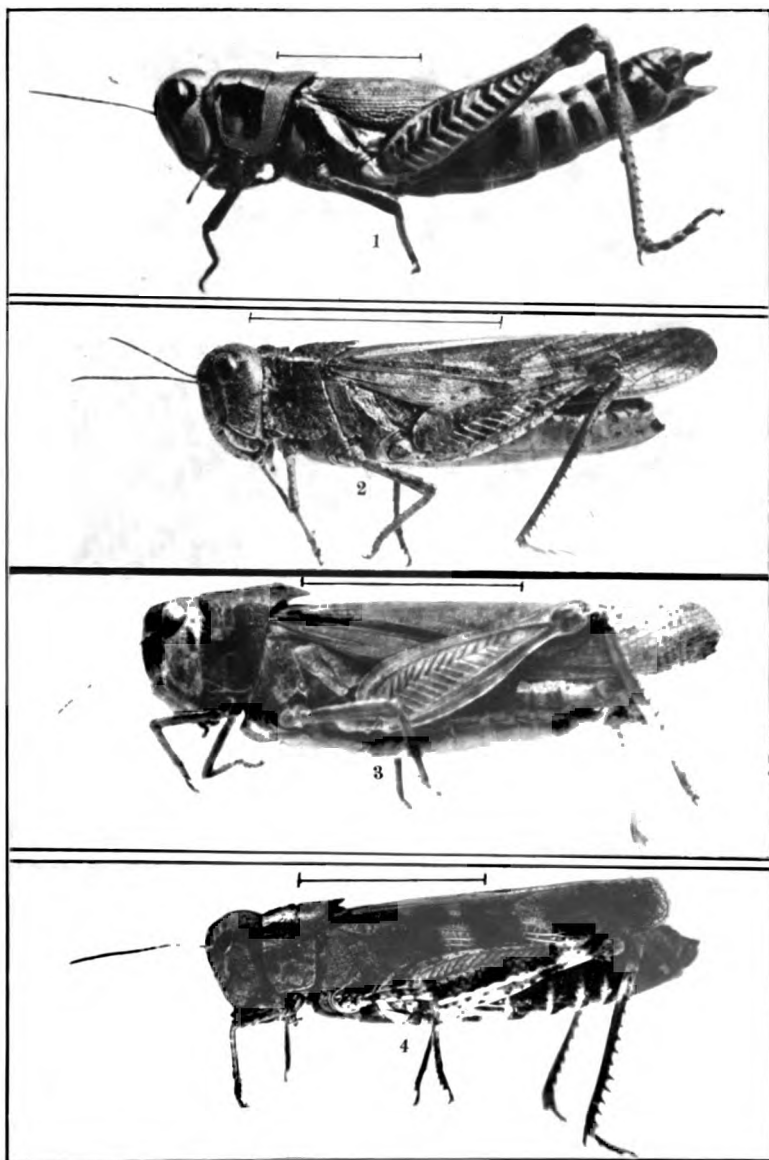
PLATE IV













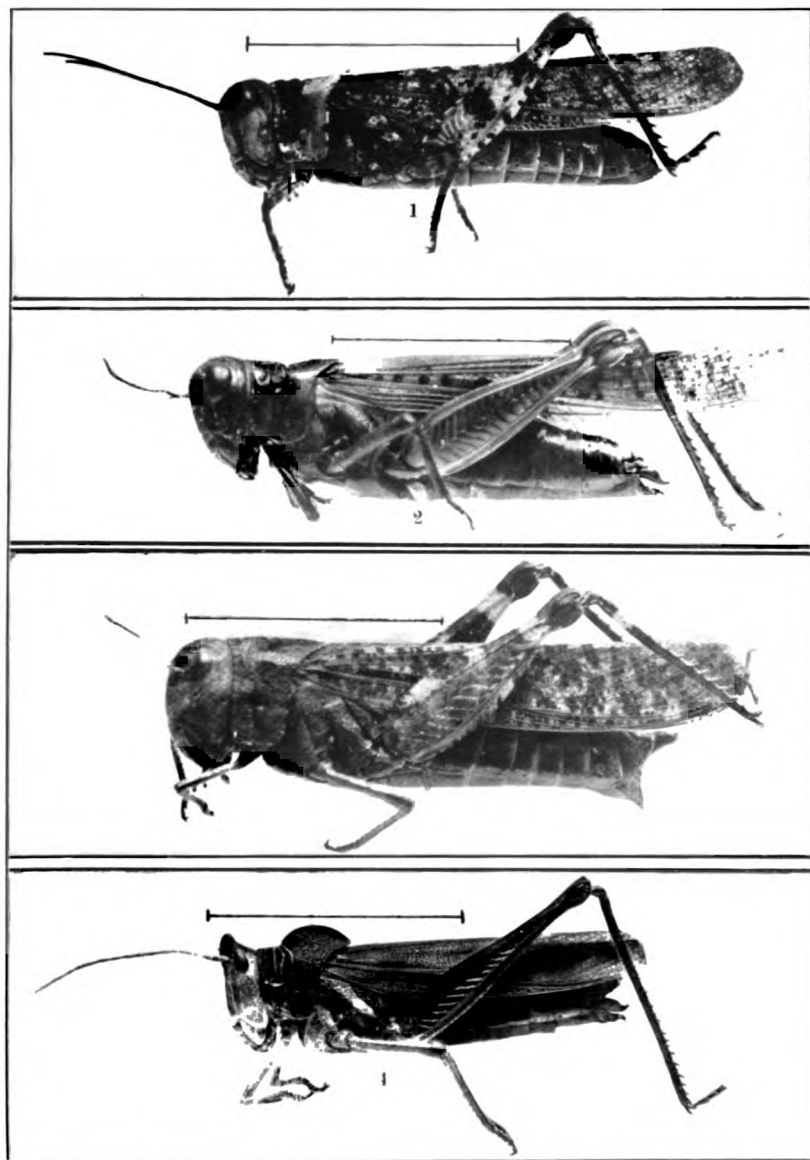
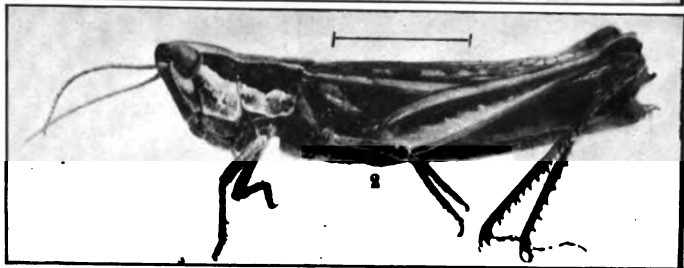
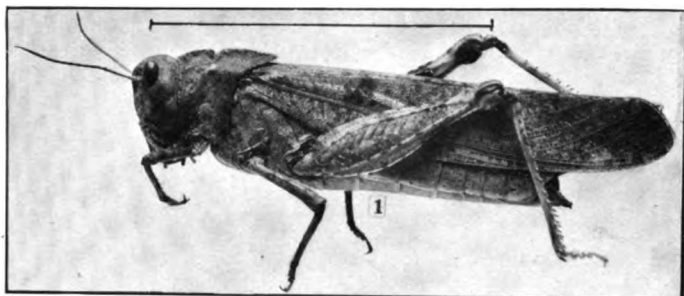




PLATE VIII





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BULLETIN No. 52, ✓

<sup>4</sup>  
Sec. 1635, 35, 7

MONTANA AGRICULTURAL

# Experiment Station,

— OF THE —

**Agricultural College of Montana.**

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## SUGAR BEETS

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**Bozeman, Montana, April, 1904.**

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REPUBLICAN,  
Bozeman, Montana,  
1903.

# MONTANA AGRICULTURAL Experiment Station.

BOZEMAN, -MONTANA.

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All communications for the Experiment Station should be addressed to  
THE DIRECTOR,

MONTANA EXPERIMENT STATION,

Bozeman, Montana.

**Notice.**—The Bulletins of the Station will be mailed free to any citizen of Montana who sends his name and address to the Station for that purpose.

# Montana Experiment Station.

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BULLETIN NO. 52.

APRIL, 1904.

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## Sugar Beets

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### The Crop of 1903

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**F. W. TRAPHAGEN**

In presenting the results of the investigation of the past year, but few comments are necessary.

It has repeatedly been shown that all the conditions for the establishment of a successful beet sugar factory could be found in several localities in the state; yet for some reason Montana, abundantly able to produce all the sugar consumed by her citizens, and much more, still obtains her supply from other sources.

Other states similarly located are increasing the number of their factories annually, and all who have embarked in the enterprise, both farmers and manufacturers, are greatly pleased with the results.

In the face of the passage of the Cuban Reciprocity Act, which has been the bugbear of the beet sugar men, the price agreed upon in Colorado for the crop of 1904 is five dollars a ton, a marked advance over the price of former years.

Montana producers could count with absolute certainty upon yields at least as great as those of other states, and the richness and

purity of the product could be maintained above the usual standard with no difficulty; while, with intelligent care in culture, these figures could be much improved. This is no mere idle speculation, but is the conclusion forced upon all who study the reports of the experiments carried on under the supervision of the Chemical department of the Montana Experiment Station during the last half dozen years.

Of our neighboring states, Utah has four factories, with a capacity for handling 2,300 tons of beets per day; Colorado, nine factories, with a capacity of 6,250 tons daily; Washington, one factory, with a capacity of 350 tons; and Idaho, one factory, capacity, 600 tons.

The world's production of sugar in 1902 amounted in round numbers to 8,500,000 long tons, of which about 5,800,000 tons, approximately 60 per cent., was beet sugar.

The consumption of sugar in the United States amounts to approximately 2,250,000 long tons, about 26 per cent. of the world's entire production.

These 2,250,000 long tons of 2,240 pounds are equal to 2,520,000 tons of 2,000 pounds each, as figured in all American calculations.

Assuming that the average product of each beet sugar factory erected in the United States is 5,000 tons, it would require 500 such factories to meet this home demand. Assuming that the present established beet sugar factories and the cane mills of the South now produce 500,000 tons—too high an estimate—it would still require 400 more factories to provide for our home consumption.

The average annual increase of consumption is 6 per cent., or 151,000 tons. To meet this increase alone there would be required to be erected EACH YEAR 30 factories of this capacity, say 500-600 tons of beets per day.

TO PAY FOR THIS SUGAR NOW IMPORTED WE ARE SENDING ABROAD ANNUALLY NEARLY \$125,000,000.

The American farmer is to-day raising wheat yielding an average gross return of \$10 per acre, which is being sent abroad to pay for sugar which he consumes, while the same lands on which the wheat is grown would produce the sugar and yield from \$65 to \$100 per acre.

This is neither economy nor common sense.

It will be seen, therefore, that, in addition to the 54 beet sugar factories which will be producing sugar during the coming season of 1903-4, nearly 400 new factories of 600 tons capacity are still to be constructed before the actual home consumption of sugar and next year's increase is supplied from beets grown on American farms, manufactured by American labor, by the investment of American capital.

No industry, agricultural or mechanical, yet established or contemplated, confers a tithe of the benefits and prosperity upon the local community which has been the invariable accompaniment of the establishment of the beet sugar factory.

None even approach it in character, unless it be the canning or creamery plants, consuming the products of local farmers; and these are insignificant in comparison.

Trade associations of booming towns, labor assiduously to secure the location of a new manufacturing industry whose sole value to the community is the pay roll disbursement of a few thousands per year.

To accomplish this they pay liberal bonuses and grant exemption from taxation.

In contrast with all such enterprises, the beet sugar factory is unique and unequalled as a producer of unexampled prosperity.

The location, in any community, of a beet sugar factory of a capacity of 600 tons—the most approved and economical unit—means the purchase of 60,000 tons of beets from the farmers of the immediate neighborhood, at an average of \$5 per ton, and a pay roll disbursement of \$60,000 per annum—a total of \$360,000 paid in cash to such community during the fall and winter months.

The effect of the distribution of this enormous sum, in addition to the ordinary disbursements, may easily be conceived.

This amount distributed among the farmers, flows into every avenue of trade, leaving its profits behind, finding its way to the banks to be again forwarded on its beneficent mission, enlivening and enriching all branches of trade and assisting the establishment of new industries.

Population materially increases; town lots command a double price; farming lands are in increased demand at greatly increased prices;

bank deposits are sometimes tripled and quadrupled; debts and mortgages are paid off, and new carriages, farming implements and pianos take their places, and abundant prosperity abounds everywhere, and civilization is advanced.

This is the simple history of the industry wherever it has been established in a proper location for the growth of beets.

There are but few exceptions, and should have been none had not the zeal and ambition of the projectors overrun their judgment in the establishment of a few plants in locations partially unfit.

### **Requisites for Location**

The following are the essential requirements of location for a successful factory:

First: BEETS, in sufficient quantity and of the required sugar content and purity. It is unprofitable to work beets containing less than 12 per cent. of sugar, and they should rather average 14 per cent. Anything above this average is so much the better.

The purity of the beet is of equal, if not greater, importance, and should be at least 80 per cent. or better. Beets of a high purity and comparatively low sugar content yield more sugar than those of higher sugar content and low purity.

By purity, or the co-efficient of purity, as it is technically called, is meant the ratio of the sugar to the solid contents of the juice.

If in 100 pounds of juice there are 15 pounds of solid matter, of which 12 pounds are sugar, the co-efficient of purity is 80 per cent., or the sugar, 12 pounds, divided by the solid matters, 15 pounds.

These beets are then said to contain 12 per cent. of sugar, with a co-efficient of purity of 80 per cent.

The remaining three pounds contain all the other mineral salts taken up from the soil, and are injurious to the extraction of the sugar, as they are chiefly molasses-forming, or melassiginic, as it is termed. One pound of these salts will prevent the crystallization, or invert, one pound of sugar.

To determine the availability of the location, soil and general conditions, extended experimental cultivation should be made, using

the best seed and following the most approved methods, having the results carefully analyzed by the State Experiment Station.

Careful analysis of the varying soils is also an advantage.

On general principles, the acreage required for a plant of any capacity should be ten times the daily tonnage capacity; for a 600-ton plant, 6,000 acres.

A trifle smaller acreage in irrigated sections might suffice, as the tonnage product is apt to be, with the proper care, nearly 50 per cent. greater.

Second: **WATER.** The water supply should be at all times adequate and not subject to fluctuations or failure, and as free as possible from mineral matter, for the same reason as above explained in reference to the purity of the beets.

If there be any doubt upon this point, a careful analysis should be made.

At least 3,000,000 gallons daily are required for the operation of a 600-ton factory; and the source of supply should always be reasonably near the factory site, to avoid excessive pumping apparatus and operating expenses.

Third: **DRAINAGE.** As the above quantity of water must be discharged from the factory heavily contaminated with soil washed from beets, with the waste lime and impurities removed from the beets and juice in the process of refining, it should not be allowed to flow into any natural water course used below for domestic purposes.

It should be impounded, if possible, in some old depression, slough, or settling basin, where the water can be allowed to drain off, when the solid matter can be used as a fertilizer for which it is especially valuable, as it contains, in a concentrated form, precisely the salts taken from the soil.

These three requirements assured, there is the most important one to mention.

This is—

Fourth: **MONEY.** Without this all the others are valueless so far as the establishment of this industry is concerned. To construct and properly equip a modern beet sugar factory, the cost will be approximately \$1,000 per ton of daily capacity; that is, a 600-ton plant will cost about \$600,000.

This first cost, however, is variable, being subject to the prevailing market rates for material and labor; the freight rates to the selected site; the character of the land in respect to drainage, water supply and railroad connections, as well as to the quality and proportions of the machinery equipment and the size and general character of the buildings provided.

The above figures will apply to a perfect plant of liberal design and ample proportions of both buildings and machinery, in which all buildings shall be of the most approved fire-proof construction.

Upon certain specifications this figure might be low, while upon others the price might be too high.

It is purely a question of what is furnished for the price charged.

This does not include the cost of railway switches, purchase of seed, or agricultural expenses, for which and for a small working capital, a further sum should be raised, varying with the conditions.

This amount of money must be fully assured from some reliable source before it is at all safe to enter into any contract for construction.

### **Factory Site**

To the above requirements might be added the desirable qualifications for a site for the erection of a factory, viz:

A practically level tract, not less than fifteen acres in extent. A larger tract would be preferable, to provide ample space for drainage basins, pulp pits, etc.

The situation should be as near as possible to the center of the beet-growing territory, and preferably near some town, to provide residences for operatives.

To be on or near a railroad, preferably two, to assure the delivery of coal and limestone at reasonable rates; in such a location that a right-of-way for a siding may be obtained.

There will be required about one mile of track for switches, sidings, and yard service.

### **Procedure to Secure a Factory**

On account of the necessity for locating factories in the midst of

the sugar beet fields, usually in farming communities, local capital is either lacking or not to be had in sufficient amount to carry through the enterprise. Outside capital must generally be secured for the purpose.

To interest and obtain such assistance, any community must first demonstrate, by indisputable proofs, that the location proposed fully answers all the requirements above enumerated; but first and foremost, that it has the necessary acreage contracted for, or that it can certainly obtain such contracts when the other preliminaries are arranged.

Having conclusively demonstrated the adaptability of the section for the production of beets rich in sugar and of high purity; having interested the farmers to a willingness to contract for the necessary supply of beets; determined upon an advantageous and suitable site, the next business is the procurement of the capital.

Some considerable local capital must be invested to inspire in others confidence in the local interest, management and support.

Let the most influential men in the community start a preliminary subscription to the capital stock of the proposed sugar company.

In the preparation of this work, take the advice of the best attorney in the community.

The capitalization of the company should be sufficiently large to cover the cost of the plant and at least \$50,000 additional for working capital.

This may be entirely in capital stock, or part stock and part bonds.

In such communities there is frequently a prejudice against the mortgaging of the property as security for a bond issue, which is but a representation of such mortgage divided into smaller parts.

This is a mistaken notion and contrary to the practice of the best financiers whenever any enterprise will earn a larger amount in dividend than is necessary to be paid in interest on money hired.

The farmer himself recognizes this principle when he hires money at 5 or 6 per cent. on a mortgage of his original farm in order to increase his earning power far above the interest charge.

To illustrate the difference, let us suppose a sugar company capitalized at \$600,000 in stock alone, and the net earnings to be 20 per cent., making \$120,000.

If, on the contrary, the capital stock were \$300,000, and the other \$300,000 of capital was realized on a bond issue of 5 per cent., the interest charge on the bonds would be \$15,000, leaving \$105,000 of the earnings as a dividend on \$300,000 of stock, amounting to 35 per cent. instead of 20 per cent., as in the other case.

As every merchant, trader, banker, land owner or farmer in the community cannot fail to derive direct benefit from the sugar factory enterprise, all should assist it by liberal subscription to the stock, aside from the handsome dividends to be anticipated from such an investment.

When \$100,000 to \$150,000 has been assured by local subscription or through local influence, the company should be legally incorporated and correspondence opened with some reliable construction company or builder for further advice or assistance, which most of them are able to give.

### **Cost of Operation**

The cost of the operation of a beet sugar factory is dependent in a great measure upon the character, capacity and arrangement of the machinery and apparatus. Compactness and convenience of arrangement are conducive to a saving of labor. The same feature, with straight piping and shortest possible lines curtails friction and saves fuel. Ample capacity, in proper proportions, with scientific by-pass arrangements, avoids delays and difficulties.

Proper arrangement and connections, and proper utilization of live and exhaust steam, hot water and wash waters, save labor, fuel, sugar and money.

A well designed and arranged factory can be easily operated by 175 to 180 men, in day and night shifts of not over 90 men each, exclusive of the superintendent.

For the purpose of a conservative estimate, however, it is set at 200 men.

The following may be considered a safely reliable estimate of

the cost of operating a factory, and the probable returns, in Michigan or in the Eastern rainfall district:

**COST OF OPERATION OF A 600-TON FACTORY, FOR A 100 DAYS' CAMPAIGN, CUTTING**

**60,000 TONS OF BEETS.**

	Total cost	Per ton of Beets
Beets, 60,000 tons (14 per cent), at \$5.16 .....	\$309,600	\$5.16
Coal, 20 per cent of beets, 12,000 tons, at \$2.50 ..	30,000	.50
Limestone, 8 per cent of beets, 4,800 tons, at \$1.50 .....	7,200	.12
Coke, 12 per cent of limestone, 536 tons, at \$5....	2,680	.044
	<hr/> \$349,480	

**SUPPLIES**

Sulphur, 20,000 lbs., at .02½c .....	\$450	
Filter cloths, 8,000 yards at 17c .....	1,360	
Oils, 2,000 gallons, at 25c .....	500	
Chemicals (average of all factories) .....	2,000	
Miscellaneous. ....	1,000	
	<hr/> 5,360	.089

**LABOR**

200 men, average \$2.25, 100 days .....	\$45,000	
Superintendent .....	3,600	
Engineer and assistants .....	2,000	
Agriculturalist .....	2,400	
Assistants .....	2,000	
Office help .....	3,000	
General manager .....	2,500	
	<hr/> 60,500	1.008

**PACKING**

44,000 barrels, at 36c .....	\$15,840	15,840	.264
(NOTE—In the West this item would be 132,000 bags at 8c, \$10,560.)			

**INCIDENTALS**

Interest, \$300,000 bonds, at 5 per cent .....	\$15,000	
Insurance .....	2,000	
Taxes (?) .....	2,000	
Repairs .....	10,000	
Dead season help .....	5,000	
Miscellaneous .....	10,000	
	<hr/> 44,500	.74

The generally accepted average extraction of sugar in factories without a molasses process is 71 per cent. of the sugar content of the beets.

Assuming the Michigan beets to contain an average of 14 per cent. of sugar, the returns in such case would be 71 per cent. of 14 per cent., or 9.94 per cent., equivalent to 198.8 pounds of sugar, say 200 pounds.

#### RECAPITULATION

	Total	Per ton Beets
Returns, 13,200,000 pounds, sold at $4\frac{1}{2}$ cents .....	\$595,000	\$9.90
Expenses, as per list above .....	475,680	7.925
Anticipated profit .....	\$118,320	\$1.975

It must be understood that these figures are based on the cutting of 60,000 tons of beets during the campaign of 100 days.

A reduction of the supply of beets would cause an increase in the proportionate expense of operation.

These figures might be somewhat varied in either direction, according to the varying conditions of quality and quantity of beets and by the varying circumstances of competition in securing acreage by factories covering closely adjacent territory.

In the irrigated sections of the West, the result is much more satisfactory. The tonnage per acre being nearly or quite 50 per cent. greater, the farmers actually receive more money per acre on a flat price per ton, and by reason of the higher sugar content of the beets, the extraction of sugar is practically 2 per cent. greater and the profit per ton of beets handled is quite \$2.50 greater than in the East, which fact will certainly lead to a very large development of the industry in those sections.

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## Beet Culture

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### General Directions for Seeding and Cultivating

There is no agricultural product from which the industrious farmer may derive so many advantages as from the sugar beet. Sugar beet raising gives the farmer many times the profit that could be derived from any other crop, while it does not interfere with other crops; but, on the contrary, by improving the condition and capacity of the soil, owing to continued and superior cultivation, produces better grain crops, besides permitting the growing of other high-culture plants and vegetables which could not be grown profitably heretofore.

### Method of Growing Beets

It is difficult to lay down general directions and rules for growing sugar beets applicable to all localities and conditions. Often expert sugar beet growers, at public meetings and through the agricultural press, give minute directions covering all the details of this intricate process.

Others, each well versed in the process of growing sugar beets, get into arguments and disputes as to the right method. In such cases each may be correct in a measure. The occasion for such disagreements lies in the fact that each person has in mind the right method for a particular locality or set of conditions. A careful study of the different sections of the United States where sugar beets are grown will lead to the conclusion that there is no single road to success in growing sugar beets. Every locality has settled conditions which will materially modify any set of methods that might apply to some other one. There are some settled rules, of course, but to a great extent the various agricultural districts of this country will have to work out each for itself the right method. The person who argues that the ground must be plowed in the fall, in order to receive the benefit of the winter frost, is not offering any argument to the Pacific coast, for instance, where many beets are grown. And he who insists that the ground should be rolled in all instances after planting, will hazard the crop if his directions are followed in many parts of Nebraska and other sections where the soil is sandy and there are

strong winds. In such cases a smooth surface offers an excellent opportunity for the wind to carry along the sharp grains of sand, cutting off the plants and destroying the crop.

There can be no general fixed rules regarding the kinds and application of fertilizers. General principles are all right when accompanied by the reasons underlying, but must always be modified to meet local conditions.

With the development of the industry in all sections which have the necessary conditions, and the acquirement of ample experience both by the farmers in the production of beets, and by the manufacturers in the making of sugar, there will come many improvements and eventually a cheapening of production, a result of great importance to all concerned in the success of the industry, because eventually the beet-sugar industry of the United States will have to meet a sharper competition with foreign producers.

There are some things settled, however, about growing sugar beets. It will be generally conceded that the ground should be plowed deep, and in most instances sub-soiled. Before the seed is planted the ground must be thoroughly pulverized by harrowing and by rolling, even if the surface has to be afterwards roughened. Advantage must be taken of the general and prevalent rain conditions. The ground must be moist enough to germinate the seed, either by rainfall or irrigation. In some localities either is used, according to circumstances. Seeds are planted at depths of from one-half to two inches, according to the prevailing conditions in the particular locality. The beets must be planted near enough together to produce a beet of certain size. This spacing depends again upon the locality and the nature and fertility of the soil. The size and quality of the beets depend materially on the right kind of spacing. The beets must be thoroughly cultivated, hoed, and hand weeded, because cultivation tends to conserve the moisture of the soil, and clean fields permit favorable action of sun and air. The sooner the beet is harvested after it is ripe the better, because further rainfall may start a new growth, producing new lateral roots, and new leaves, thus greatly reducing the sugar content and purity of the beets.

### **Preparing the Seed Bed**

Having selected the land, give it a deep plowing in the fall, if possible, and follow by a sub-soiling, and allow it to lay exposed to the action of the elements during the winter.

In the spring, the land should be again plowed about eight inches deep, after which it should be thoroughly pulverized by disking, harrowing and rolling or planking. It is not necessary that all these methods be used at once, but enough of them must be used to accomplish the end in view, which is to thoroughly pulverize the soil.

Special implements are being constantly devised to accomplish this, and all the operations in beet cultivation, harvesting, and topping.

### **Seed**

So far, almost the entire quantity of seed used in this country comes from Europe, that from Germany appearing to be best adapted to our conditions and to produce the best results.

There is some choice to be exercised in this regard. The sugar companies usually furnish their farmers with seed, taking pay in beets.

Not less than 15 pounds of seed to the acre should be used to insure a full, even, and regular stand. Unless the stand be good, there will be many bare spaces, greatly reducing the yield.

A disposition to economize seed or to make the amount furnished cover a larger acreage will be found to be false economy and should not be attempted.

### **Planting**

The seed should be sown with a drill made for the purpose, in rows eighteen inches apart, or of sufficient width to allow of the passage of a horse when cultivating.

When irrigation is practiced, seed is preferably sown in ridges about twenty inches apart to allow for irrigation between the rows so as not to burn the leaves.

The seed should be planted from one-half to one and one-half inches deep, depending upon the moisture in the soil; the shallower the planting, the more vigorous will be the plant. The fear that the

plant may die for lack of moisture is unfounded, as the sprouted seed sends down a long root to the depth of several inches, and later even to two or more feet, from which the beet derives moisture and sustenance.

It should always be borne in mind that the sugar in the beet is derived entirely from the air and sunshine, consequently the tops should have ample space in which to secure all the benefit from these sources. The increase in sugar content will more than make good the decreased tonnage, although growing and breathing space will not necessarily tend to decrease tonnage.

Planting should not be done until the ground becomes warm with a probability of settled weather conditions, say in May in the rainfall districts. In the irrigated districts this must depend upon the general conditions; in some places planting may be done from December to June. In Montana, in May or early June.

### **Germination**

The seed will germinate in about a week after planting if the if weather and soil conditions are favorable.

Care should be taken during this period that the ground does not become baked; if this occurs, the farmer should know how to overcome the difficulty with a harrow.

### **Bunching and Thinning**

When the plant has three or four leaves the bunching must be done.

This is done by passing down the row and, with a stroke of the hoe, cutting out a part of the plants the width of the hoe, leaving bunches from 6 to 10 inches apart.

After bunching, or when it is fairly under way, the thinning should be begun.

This, up to this time, has been, and probably always will be, done by hand, laborers crawling along the rows and removing from each bunch all except the most thrifty plants. These plants should be left about six inches apart in good, rich soil, or up to ten or twelve inches in poor or thinner soil.

This is quite the most important operation connected with beet

growing, as its proper performance has a great influence upon yield, both in tonnage and sugar. The vigor of the plant depends upon its being done at the right time, governing the size of the beets, while spacing to the proper distances apart has an important influence upon the sugar percentage.

The aim of the farmer should not be to grow large beets, which run to fibre and are low in sugar, while small beets are more expensive to handle. Beets weighing from one to two pounds are by far the best for the farmer and the factory.

### **Cultivating**

The first cultivation is performed in the bunching and thinning, when the laborer presses the dirt firmly around the beet plant and removes whatever grass or weeds may be present.

After this the weeds should be kept down and the ground kept loose and pulverized, which can be done by hoeing or horse cultivation, using any of the implements made for such purpose. This should be done as often as needed, three times generally being sufficient, or until the plants are large enough to shade the ground, when work among them with plow and horse would break off the leaves.

### **Irrigation**

Where irrigation is practiced the farmer has an opportunity to control the growth of the beet and the development of its sugar to a much greater degree than is possible in the humid sections.

In general, the rules of irrigation as applied to other crops, may be successfully used with sugar beets. It would be well, however, in order to secure a greater downward growth of the beets, to withhold the application of water in each case until the leaves begin to turn yellow. In this way the disproportion of tops to the rest of the root may be reduced and the proportion of sugar correspondingly increased. It is also advisable to avoid very late irrigations.

### **Harvesting**

When one is accustomed to sugar beet fields, it is easy to determine when they are ripe. This point is usually determined, however, by analysis to ascertain the sugar content and purity of the beets.

After the growth of the top and root and cultivation ceases, the beets begin to store up sugar through the leaves, and the sugar and the purity increases as they approach maturity.

When a field of beets is ripe, the leaves tend to droop and the whole field takes on a yellow appearance, which cannot be mistaken by one accustomed to deciding the period of ripeness.

There are several kinds of harvesting plows, beet pullers and toppers, many of which have lately been patented, from which a satisfactory implement may be chosen.

Having been loosened by either of the ordinary machines, laborers follow, throwing the beets in piles.

### **Topping**

This is done by laborers with a sharp knife, made especially for the purpose, striking a quick, sharp blow, cutting off the top square across as low as the lowest leaf stem. The beets are thrown into large piles and the tops plowed under or used for fodder.

The topping is a very particular and important operation.

The sloping crown of the beet bearing the leaf-stems contains much the larger proportion of the mineral salts in the vegetable, which are very objectionable in the manufacture of sugar, every pound of such salts preventing a pound of sugar from crystallizing.

Beets not topped properly are re-topped by the agricultural department of the factory and the difference in percentage of weight, calculated on the samples, is deducted as tare.

In climates where there is no danger of wet or freezing weather, the roots may be left on the ground unharvested for a long time.

### **Siloing**

While beets should be harvested as soon as they are ripe, to avoid the deteriorating effects of frost or rain, yet not all beets can be delivered to the factory at the same time. The beet sheds have not sufficient capacity. Many companies require that a certain portion of the beets shall be siloed in the fields where they are grown. This is accomplished by placing them in single piles containing a good load, or in long ricks.

Plows are run up and down alongside of these ricks or piles, and the soft dirt is thrown over the beets to the depth of several inches. Then hay, straw and beet leaves are thrown on top of that. Holes are left for ventilation. Beets can be kept for some time in this manner.

Freezing of the beets does them no particular injury, and does not appreciably diminish the sugar content, provided they can arrive and be worked at the factory before thawing out.

Thawing after freezing reduces the amount of sugar and the purity, and must be guarded against.

The delivery of beets as well as the specific instructions for growing are regulated by the agricultural department of the various factories, and the whole progress of the work is usually supervised by the skilled members of that department employed by the factory.

It is decidedly to the farmers' interest as well as to that of the factory that such instructions should be graciously received and carefully followed.

It cannot be too strongly impressed upon the minds of farmers that the interests of both farmer and factory are identical and mutual; what benefits the one adding to the success of the other, and no spirit of antagonism or differences should be permitted to arise.

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## General Data Condensed

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The amount of fuel required per ton of beets varies from 15 per cent. to 21 per cent. The latter was the average of Michigan factories for the campaign of 1901-2. Proper connections, careful attention to details and skillful utilization of heat units and the hot water supply should keep the amount approximately at the lower figure.

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The quantity of lime rock used is about 8 per cent. of the weight of the beets when using the ordinary milk of lime for carbonatation. Where the Saccharate of Lime process is used for treating the molasses, the proportion will be from 16 to 20 per cent.

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The quantity of Coke is about 10 to 12 per cent. of the weight of the Lime Rock.

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The amount of Sulphur used is about 200 pounds per day; other supplies about \$50 per day.

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The number of men employed, outside the office force, in some of the factories is 170 to 180. In some others, of the same capacity, 250 are required.

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The annual disbursement for labor, including office, will be about \$60,000.

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In raising and harvesting the crop of beets for the Michigan factories for the campaign of 1901-2, there were engaged 26,966 men, 1,844 single horses, and 4,834 double teams employed during the season.

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The actual number of contractors raising beets for the same factories for that season was 16,848. This represents the same number of farmer's families and, on a basis of five members to the family, represents 84,240 persons actually interested in the agricultural operations of the Beet Sugar Industry of Michigan in that year. Last year these figures were presumably 25 per cent. greater.

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Beet seed is purchased by the factories in the month of Decem-

ber, distributed to the farmers in the month of April and paid for by the farmers from the sale of beets in the fall.

The Beet Sugar Industry is the agricultural industry in which the farmer is able to sell his crop, on a reliable contract, at a fixed price, before the seed is planted.

He is thus independent of the action of the law of supply and demand, or of the many contingencies of the market on other crops at time of harvesting. He is not subjected to delays in payment nor compelled to hold his crop for a better market.

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Sugar beets will withstand a longer drought and also a more excessive rainfall than any other known staple crop. The danger of loss from bad weather conditions is thus minimized.

### **Calculations**

In making the various calculations in the Beet Sugar Industry, it will be apparent that they are approximately correct when expressed in decimal proportion; that is, the relation of each to the other is expressed in some multiple of ten.

In the Eastern section the average tonnage per acre is set at 10 tons.

The acreage of beets to be contracted for should be 10 times the daily capacity.

The tonnage of beets worked is practically 10 times the amount of sugar which should be extracted.

The campaign is 100 days.

The approximate cost of the completed plant is about \$1,000 for each ton of daily capacity.

These estimates are sufficiently near for all practical purposes.

### **Refineries vs. Home-Grown Sugar**

Eastern refiners buy brown (raw) sugar, produced from cane in the tropics or from beets in Europe. This sugar has had expended upon its production fully 90 per cent. of all the labor and other cost.

The cost of refining is from 30 to 40 cents per 100 pounds, of

which not exceeding 15 cents is for American labor.

This sugar is melted, reboiled and clarified by passing through bone black (animal charcoal) and the refined sugar separated from the molasses precisely as in the Beet Sugar process. In fact, the machinery is identical with that in the sugar end of the beet sugar factories, except for the addition of the char-filters for the necessary clarification.

The present price, April 1, 1903, of raw sugar, 96 degrees Centrifugal, landed in New York, cost and freight, is 2 1-16 cents, and this all goes to the foreign producer.

The American beet farmer receives for one ton of beets containing 14 per cent. of sugar, in Michigan, \$5.16. Upon the assumption that the factory is able to extract from this 200 pounds, the farmer receives 2.58 cents per pound for the sugar still in the beets, in the shed, upon which all labor and factory expense must be expended.

The duty on raw sugar polarising 96 degrees is \$1.68½ per 100 pounds.

The cost, duty paid, is about 3¾ cents per pound.

### The Future

It is estimated that in 1910, the amount of sugar required for consumption in the United States, above that produced from home-grown cane, will be 3,000,000 tons.

Europe, with much less available beet area, produced in 1900, 5,950,000 tons of beet sugar.

To produce 3,000,000 tons of beet sugar annually would require 500 plants, each having a daily capacity of 600 tons.

These plants would represent the following investment and annual business:

Invested in plants.....	\$300,000,000
Working capital.....	50,000,000
Acres of beets.....	3,000,000
Valuation of land growing this crop.....	150,000,000
Tons of beets.....	27,000,000
Tons of sugar.....	3,000,000
Value of beets.....	135,000,000

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Annual pay roll for labor in factories.....	42,000,000
Tons of coal used.....	5,500,000
Tons of lime rock.....	1,890,000
Tons coke.....	208,000
Freight paid railroads.....	27,000,000
Annual payments, bags and barrels.....	6,000,000
Number of farmers raising beets.....	750,000
Men employed in factories.....	125,000
Men employed raising beets during season.....	1,200,000

## Statistical

### Present Sources of World's Sugar Supply

	BEET			
	1901	1900	1899	1898
Germany .....	2,270,000	1,979,098	1,798,631	1,721,718
Austria .....	1,250,000	1,094,043	1,108,007	1,051,290
France .....	1,200,000	1,170,332	977,850	830,132
Russia .....	1,050,000	920,000	905,737	776,066
Belgium...	350,000	340,000	302,865	244,017
Holland .....	190,000	178,081	171,029	140,763
Other European Countries .	400,000	387,440	253,929	209,115
Total foreign .....	6,710,000	6,068,994	5,518,048	4,982,101
United States .....	150,000	76,859	72,944	32,471
Total beet .....	6,860,000	6,145,853	5,590,990	5,580,572

	CANE			
Cuba .....	875,000	635,856	308,540	345,260
Java .....	765,000	710,120	721,993	689,281
Brazil .....	215,000	190,000	192,700	154,495
Mauritius .....	145,000	175,267	157,025	196,487
Australia .....	117,000	111,554	123,289	192,247
Argentine Republic .....	115,000	114,252	91,507	72,000
Peru .....	105,000	105,000	100,381	61,910
Other Foreign Countries...	753,000	731,880	681,219	748,926
Total Foreign Cane .....	3,090,000	2,773,929	2,376,654	2,450,606

#### UNITED STATES:

Louisiana .....	290,000	275,000	132,000	245,511
Porto Rico .....	100,000	80,000	35,000	53,826
Hawaiian Islands .....	300,000	321,461	258,520	252,507
Philippine Islands .....	70,000	52,000	62,875	93,000
Total, U. S. and posses-				
sions .....	760,000	728,461	488,305	644,844
Total cane .....	3,850,000	3,502,390	2,864,959	3,095,450
Total Cane and Beet .....	10,710,000	9,648,243	8,455,951	8,110,022

To illustrate the comparative growth of the beet sugar industry in the United States and Europe, the following table will be interesting:

**Beet Sugar Production**

	United States. (Tons.)	Europe. (Tons.)		United States. (Tons.)	Europe. (Tons.)
1870	400	899,600	1892	12,018	3,442,198
1872	500	1,018,500	1893	19,550	3,889,845
1878	200	1,418,800	1894	20,092	4,790,532
1880	500	1,747,500	1895	29,220	4,285,429
1883	535	2,146,470	1896	37,536	4,916,498
1884	953	2,574,047	1897	40,399	4,831,774
1886	800	2,732,200	1898	32,471	4,982,101
1888	1,010	2,724,000	1899	72,944	5,518,048
1890	2,800	3,707,200	1900	76,859	6,068,994
1891	5,359	3,501,920	1901	150,000	6,710,000

**Detailed Supply of the United States, 1901****DOMESTIC**

Cane .....	292,150 tons.	12.4 per cent.
Beet .....	124,859 tons.	5.2 per cent.
Molasses Sugar .....	17,977 tons.	.7 per cent.
Maple .....	5,000 tons.	.2 per cent.
	<u>439,986 tons.</u>	<u>18.5 per cent.</u>

**FROM INSULAR POSSESSIONS, CANE**

Hawaii .....	309,070 tons.	13.2 per cent.
Porto Rico .....	64,052 tons.	2.7 per cent.
Philippine Islands .....	5,100 tons.	.2 per cent.
Total from Insular possessions .....	<u>380,449 tons.</u>	<u>16.1 per cent.</u>

Total, Domestic and Insular possessions .....	<u>820,435 tons.</u>	<u>34.6 per cent.</u>
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**FOREIGN**

Cane .....	1,292,080 tons.	54.6 per cent.
Beet .....	217,286 tons.	9.6 per cent.
Refined .....	42,515 tons.	1.7 per cent.
Total Foreign .....	<u>1,551,881 tons.</u>	<u>65.4 per cent.</u>
Grand Total .....	<u>2,372,316 tons.</u>	<u>100.0 per cent.</u>

**Average Increase in Total Consumption Per Year for Twenty Years**

France .....	6.18 per cent.	England .....	3.50 per cent.
Germany .....	6.91 per cent.	United States .....	6.94 per cent.
Austria .....	4.65 per cent.		

### Sugar Consumption, Dominion of Canada, 1900, With Sources of Supply

	United Kingdom and British pos- sessions, Tons.	Imported from United States Possessions and Dependencies, Tons.	Other Cane Tons.	Other Beet Tons.	Total Tons.
Raw .....	11,020	2,689	3	112,613	126,325
Refined .....	1,238	12,265	1,684	1,247	16,434
	12,258	14,954	1,687	113,860	142,759

It will be seen that more than 75 per cent. of the total supply in Canada was from sugar beets.

The customs duties in Canada are 71½ cents per 100 pounds on raw sugar, (96 degrees, Centrifugal) and \$1.20 on refined sugar, against \$1.68½ and \$1.95 respectively in the United States. This duty should be materially increased before the production of beet sugar can attain any considerable development.

Having had an opportunity during the last few months to become acquainted with the conditions in Colorado, I will give some data showing what the establishment of a factory means to a community.

#### Loveland, Colo.

The Loveland factory is said to employ 400 men and boys during the sugar making season, the payroll being about \$25,000 per month, or for the 120 days, or four months, of the factory campaign, about \$100,000.

About 35 of the skilled factory employes, the office force, the agricultural superintendent and his corps of assistants, are employed the year round, representing a payroll for the eight months during which the factory is idle, of about \$4,000 per month, or about \$32,000, making the annual pay roll about \$132,000.

The local beet growing industry, following the erection of the Loveland factory, has resulted in the immigration into the district of about 1,500 laborers, old and young, who came to Colorado from Nebraska,

The wages paid in the beet fields for ordinary common labor, doing hand-work, range from \$1.50 to \$2.50 per day, if reckoned that way, but the field laborers generally contract to do the necessary hand-work,

viz., the thinning and hoeing, second and third hoeings, pulling and topping, for \$20 per acre; father, mother and children working on the family contract.

Around Loveland beets are regarded as not merely a more profitable crop than wheat or other grain, or alfalfa, or potatoes, but as a safer crop, as much less liable to serious damage from hailstones.

The beet pulp produced by this factory is sold to local stock feeders at 35 cents per ton, being mainly used for sheep.

It has necessarily given quite an impetus to local stock feeding.

The beet tops, left in the fields after the beets are harvested, are valuable either as feed for cattle and sheep, or as a fertilizer when ploughed under.

It is difficult to overestimate the benefit of this factory to the Loveland district. It has already materially enhanced the market value of all farm lands within its sphere of influence; promoted diversified farming; rotation of crops and more intensive agriculture. The \$1,472,000 paid to local growers for beets during the three seasons the factory has been in operation, has necessarily gone into general circulation and benefitted not merely the Loveland district in particular, but Colorado in general, in a variety of ways, insomuch that the continued success of the enterprise is, or should be, a matter of interest to every citizen of Colorado.

### **Sugar City, Colo.**

The beet sugar factory of the National Sugar Manufacturing company at Sugar City presents somewhat different circumstances to the other beet sugar factories in Colorado.

Sugar City is situated fifty-six miles east of Pueblo on the line of the Missouri Pacific railway, or about 160 miles by railroad from Denver.

In the spring of 1899 the site of the present Sugar City was merely "an expanse of plain and sky," a "round-up" point for the open range cattle industry, and tenanted by prairie dogs and occasional coyotes. Sugar City was incorporated in June, 1900, and to-day has a population of about 1,500, with hotels, business houses, a bank, a fire

department, a \$10,000 school house and a \$20,000 water works plant the bonds of which were sold at par.

All this has followed the erection in 1899 of a beet sugar factory at Sugar City by the National Sugar Manufacturing company.

It naturally took some little time to get the beet growing industry started. The first year the factory was erected remarkable progress was made, considering the difficulties which had to be overcome. The industry was entirely new to that section. The farmers were unfamiliar with the method of raising the beets, laborers had to be brought from distant places and were compelled to live in tents for the greater part of that year, and the land was but a vast area of new and unbroken prairie. Nevertheless, 12,000 tons of beets were raised the first year.

### **A Large Territory**

The area tributary to the factory extends along the line of the Missouri Pacific railroad, practically as far as Pueblo, taking in the flourishing agricultural communities of Ordway, Olney, Fowler, Baxter, Vineland, etc., and representing at least 50,000 acres of irrigable land. The main crops of this tributary area, until the advent of the factory, were alfalfa, grain, etc. There is not much live stock, except on the open ranges north and south. There is little dairying or poultry raising, but there are numerous orchards, and honey is shipped out by the carload. In the vicinity of Ordway, about six miles west of Sugar City and the factory, the farms are of good size, the farmhouses and out-buildings substantial and well painted. The farmsteadings are invariably surrounded by orchards, shade trees, hay and grain ricks, and usually also have a cluster of white tents, occupied by the laborers for the beet fields.

The National Sugar Manufacturing company owns 12,000 acres of land surrounding Sugar City and the factory, the Missouri Pacific railway passing diagonally through the center of the tract. This body of land, which lies in compact form, is an excellent alluvial deposit of light loam, mixed with fine gravel, yielding readily to the plow and easy of cultivation.

Just north of this area runs the Colorado canal, owned by the Twin Lakes Land and Reservoir company, from which the whole of the 12,000 acres of the National Sugar Manufacturing company is irri-

gable. The Meredith lakes south of the town, have a circumference of thirteen miles, the volume of water in which, though varying with the seasons, never fails.

### **The Water Supply**

The National Sugar Manufacturing company owns extensive water rights, Lake Henry, fed by means of a priority right from the Arkansas river through the Colorado canal being the base of supply. In other words, from Twin Lakes, 2,000 acres in extent, with average depth of eighty-five feet, in Lake county, at an altitude of 9,200 feet, the water is carried in a natural canal to the Arkansas river, a distance of nine miles. Then down the Arkansas river for a distance of 150 miles to Boone, east of Pueblo, at Boone taken into the Colorado canal and conveyed a distance of thirty-five miles to Lake Henry and from there, through a wooden stave pipe to Sugar City and the adjoining land of the National Sugar Manufacturing company. When the Arkansas river supply becomes short, as it usually does during the middle of the summer, the headgate at Twin Lakes is opened and the necessary amount of water liberated, which in about two days, via the Arkansas river, the Colorado canal and Lake Henry, is delivered for irrigation use around Sugar City.

In addition to this, the great storage reservoir of Lake Henry, four miles northwest of Sugar City, holds a vast volume of water ready for any emergency of threatened drought.

It is said that the before-mentioned facilities preclude shortage of water around Sugar City.

### **Land Under Cultivation**

The company is cultivating a considerable portion of its 12,000 acres of land, 4,000 acres being devoted to beets. A quantity of the company's land is leased to other beet growers and the remainder is grown by the company to alfalfa and grain crops as a precursor to beets.

The total cost to the company of handling its portion of the 12,000 acres this season will be about \$250,000, by far the greater part of the expense being on the 4,000 acres of beets.

In addition, about 140 beet growers, owning or leasing land along

the line of the Missouri Pacific railroad, with an average of eleven acres of beets each, have contracted to furnish the factory this season with the beets from about 1,500 acres.

Taking the average yield per acre at the low estimate of ten tons, the factory should slice from all sources between 40,000 and 50,000 tons of beets this season.

For beets which contain 14 per cent. sugar, the company pays \$4 ton, allowing 25 cents extra per ton for each 1 per cent. of sugar. The average sugar contents are  $17\frac{1}{2}$  per cent. and in some exceptional cases the beets test as high as 21 and 22 per cent. The average price the growers receive is about \$4.87 per ton. Many of the beet growers raise an average of twelve tons to the acre, while some raise as high as fifteen and twenty tons per acre.

### Some Statistics

One grower near Ordway received from the company for beets delivered from two and three-quarters acres, \$365.39 or \$132.84 per acre. He did a large part of the work himself, but assuming that the value of his own labor and whatever other labor he had to pay for was \$32 per acre, it still left a profit of \$100 per acre.

Another company received from the company about \$2,500 for the beets from forty acres.

Another grower, who leased forty acres of the company's land, raised an average of sixteen tons per acre of high quality and received from the factory therefor about \$3,000.

The cost of production of an acre of beets at Sugar City is conservatively stated as follows:

Plowing	-	-	-	-	\$3.50
Irrigating, winter (once)	-	-	-	-	.75
Irrigating, summer, (three times)	-	-	-	-	1.00
Harrowing, (three times)	-	-	-	-	.90
Seed	-	-	-	-	3.00
Seeding	-	-	-	-	.50
Cultivating (5 times)	-	-	-	-	2.00
Bunching and thinning, by contract labor	-	-	-	-	6.00
Hoeing, by contract labor	-	-	-	-	6.00

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Pulling and topping, by contract labor	-	6.00
Plowing up beets	- - -	2.00
Hauling (ten tons)	- - -	5.00
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Per acre	- - - -	\$36.65

It is said that the above figures can be somewhat reduced by less cultivating and by the grower doing his bunching and thinning, hoeing, pulling and topping by the month. Even on the above showing, a production of fifteen tons per acre means over \$73 per acre, or a net profit of nearly \$30 per acre, while at ten tons per acre there is still a fair profit to the grower

### Heavy Pay Roll

In addition to the amount paid this season by the factory to independent growers for beets, the company has an annual payroll of between \$150,000 and \$200,000, covering the 190 factory employes during the sugar making season of about 120 days, commencing October 1, the maintenance of the administration crops, about forty in number, during the other eight months of the year, and the force required to run that part of the company's 12,000 acres of land, not in beets, operated by the company. Further large sums are expended in Colorado in the purchase of coal, lime rock, etc., and in railroad freight.

The factory treats 500 tons of beets per day during the season and produces 120,000 pounds or sixty tons per day of pure white granulated sugar therefrom.

Its modus operandi of manufacturing resembles that at other Colorado factories sufficiently to call for no repeated description here. As it stands to-day, the factory has cost approximately \$500,000.

During the agricultural season the company employs about 1,000 persons old and young, on the acreage of beets grown by itself, while the independent growers employ outside help to the number of at least 500 persons.

The usual price for hand work is about \$18 per acre; man and two horse team get \$3 per day, and irrigators \$1.75 per day. One beet worker received one check for \$900 for his personal contract labor from May 1 to November 1. Many others received amounts equal to this for similar contracts.

### **Foreign Labor**

The bulk of this labor is performed by people commonly known as Russians, but really people of German race and language born in Russia. It is said that these German laborers around Sugar City, while coming here from Nebraska, came originally from the provinces of Saratov and Samara in the valley of the Volga and are descendants of German emigrants who settled in that part of Russia in the middle of the Eighteenth century. They are said to speak the German which prevailed over a century ago, like the Canadians of Lower Canada largely speak the French which prevailed in France at the time when their ancestors emigrated from France to Lower Canada. These German-Russian laborers have built a Lutheran church and have their own resident pastor. They are phenomenally industrious, father, mother, and children working in the fields side by side early and late. A number of the men who came first have purchased, with their savings, serviceable teams and wagons and do most of the beet team work at so much per ton. Some of the older comers have ceased to dwell in tents, having acquired small tracts of land and erected their own houses.

### **Many Phases**

There are also about 100 Mexicans, chiefly engaged in loading or unloading beets rather than field work, but they are transients, only staying around Sugar City for the sugar making season.

The residum pulp from the factory has given an impetus to the local feeding of cattle and sheep, one packing company of Pueblo feeding 3,000 head of steers and 500 sheep at Sugar City this season.

The National Sugar Manufactory company has reclaimed and put into profitable production a large tract of Colorado land.

It has annually, for five consecutive years, disbursed large sums of money in the employment of profitable labor in Colorado and for beets produced by independent growers. It has added another prosperous community to the state. It obviously merits full appreciation and support from the citizens of the state, no matter where resident of the state.

### **The Greeley District.**

The Greeley district was the pioneer in Colorado of agriculture on

any considerable scale, by means of irrigation, and its success in the '70s gave the impetus which resulted in similar enterprises and reclamation of dry land at many other points in the state. Had the Greeley colonists been less indomitable in the early '70s and allowed themselves to fail in their efforts, the development of agriculture, as it exists in Colorado to-day, might have been postponed possibly twenty years. The whole state, therefore, is infinitely indebted to the Greeley colony for its pioneer work of converting semi-arid lands into fertile fields by artificial irrigation from the streams fed from the melting snows and eternal springs in the mountains.

Of the seventy-five square miles of irrigated, cultivated land surrounding Greeley the respective acreages of various crops for the season of 1903 are estimated in the following order: (1) alfalfa, (2) potatoes, (3) wheat, (4) sugar beets, (5) oats, (6) barley.

That portion of the land which has been in continuous cultivation since the early '70s is more productive now than ever before for various reasons, viz: (1) more intelligent and economic use of water, (2) more thorough cultivation, (3) the utilization of alfalfa, plowed under as a fertilizer, (4) rotation of crops, (5) increased use of barnyard and sheep pen manure, (6) improvement in agricultural implements and appliances and in grade of farm horses.

### **High Wheat Average.**

Years ago the average local wheat crop ranged from twenty-five to thirty bushels per acre, while to-day, it is said to range from thirty to as high as sixty bushels per acre, the minimum average being forty bushels.

Potatoes formerly used to range from seventy to eighty sacks (of 100 pounds each) to the acre, while for the season of 1903 they are said to average at least 100 sacks per acre.

With the increased average yield of wheat and potatoes, the cost of production per bushel and per sack has decreased.

The estimated cost of raising wheat around Greeley is said to be about \$10 per acre. An average yield of forty bushels per acre, at present price of 90 cents per bushel, means \$36 per acre, or a profit to the grower of, say, \$25 per acre.

The estimated cost of raising potatoes around Greeley is said to be from \$30 to \$35 per acre, including seed. An average yield of 100 sacks per acre, at present price of 70 cents per sack, means \$70 per acre, or a profit to the grower of, say, \$35 per acre.

It is estimated that Weld county this season has raised and will ship 8,000 cars of potatoes, averaging at least fifteen tons per car, of which at least 4,000 cars, or 60,000 tons, were raised in the ten square miles immediately surrounding Greeley, where the "dugout" for potato storage is an adjunct on practically every farm.

These Greeley potatoes, on account of their superior quality, have been for years shipped throughout the Southern and Middle states, and even as far east as New York and Boston, 2,000 miles by railroad.

### **Beet Sugar Factory**

In 1902 the Greeley Sugar company built and completed a beet sugar factory at Greeley with a daily capacity of 600 tons of beets.

The officers of the company are: C. S. Morey, president; C. A. Granger, vice president; M. D. Thatcher, treasurer, and W. A. Dixon, secretary.

The factory as it stands to-day, including first cost and subsequent additions and improvements, represent a cash investment of \$750,000. The factory premises cover sixty-five acres, and the site is ideal.

While there is a sufficient resemblance between the various factories of the state to render unnecessary a special description of the Greeley factory, it may be said of this factory, that it was evidently designed and built by experienced men with a view to maximum efficiency at minimum first cost and subsequent cost of operation. The factory has a well, through the gravel down to bed rock, from which 1,000,000 gallons per day of pure water is pumped and used exclusively in the manufacture of sugar.

### **Wide Territory Covered.**

In 1902, its first season, the factory sliced 40,000 tons of beets, paying the farmers \$180,000 and making 8,000,000 pounds of sugar.

For the season of 1903 it is estimated that the factory will slice 55,000 tons of beets, paying the growers therefore \$247,000 and making therefrom 12,000,000 pounds of sugar.

In the season of 1903, 4,800 acres of beets were contracted for the factory, the territory being far reaching at points along the Union Pacific railroad, on the Denver line as far as Fort Lupton, twenty-six miles from Greeley, and along the Julesburg line as far as Deuel, forty miles from Greeley. The factory has four dumping stations on the line of the Union Pacific, viz., at Goodrich, Kersey, LaSalle and Fort Lupton. About three-fifths of the factory's supply of beets this season came in by railroad from various points along the Union Pacific and the remaining two-fifths were delivered by wagon from growers within a radius of about five miles from the factory.

There were 550 individual growers who averaged about nine acres each, the average yield being about twelve tons per acre. One man with twenty-two acres raised twenty-six tons per acre. Other growers with smaller tracts raised as high as thirty and even thirty-two tons per acre, showing what can be done.

### **Cost of Production**

The cost of production of the beets is said to range from \$30 to \$40 per acre, depending on what the grower has to hire. It is said that a man can rent land, pay for water, hire a foreman and pay for all necessary work and still raise beets at a total cost of not to exceed \$40 per acre.

In 1902 the payroll of the factory during the sugar making season, commencing October 10 and finishing January 17, is expected to be about \$70,000, and during the fiscal year \$19,000.

The beet pulp from this factory amounting to over 20,000 tons this season, is giving an impetus to local stock feeding, mostly sheep. Ninety per cent. of the pulp will be fed to stock within a mile and a half of the factory, and two cars of pulp per day are being shipped to points along the Union Pacific, as far as Fort Lupton on the Denver line, and as far as Masters and Orchard on the Julesburg line.

The price of the beet pulp is 35 cents per ton f. o. b., also 35 cents per ton at the silo for local beet growers, and 50 cents at the silo to non-beet growers. According to the United States government report beet pulp is worth \$1.22 per ton for stock feeding purposes.

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**Sheep Industry.**

Near the factory the company has 5,000 Mexican and Southern sheep, including many old ewes, being fattened on pulp and hay. They were delivered in the factory pens on October 28 and it was estimated there were 1,000 head ready for market.

It is estimated there will be a net profit of at least \$1 per head on these 5,000 sheep, besides 1,000 loads of manure, which is sought after by farmers at 75 cents per load. These pulp fattened sheep are shipped to Missouri river points as far as Chicago.

The Greeley beet sugar factory represents a cash investment of \$750,000, and in its two seasons' operations has practically already paid \$427,000 for beets and \$168,000 in payrolls, or a total local disbursement in two years of nearly \$600,000, to say nothing of cost of coal, lime rock, railroad freight, taxes, etc.

**Eaton, Colo.**

Eaton has a population of about 1,000, and has two banks, two hotels, two school houses, costing \$30,000, a newspaper, a gas plant, water works system, sewerage system, telephone system, three churches, elevator with a capacity of 110,000 bushels, flouring mill of 400-barrel daily capacity, and a beet sugar factory of 600 tons daily capacity. There are no saloons.

The agricultural country tributary to Eaton is about 100 square miles in extent, and contains several thousand population. In it there are about 150 miles of main irrigating canals, mostly fed from the Cache la Poudre, but some from the Larimer river.

**A Great Farming Country.**

Taking the average 160-acre farm, the various crops are generally represented about as follows: alfalfa, forty acres; potatoes, forty acres; sugar beets fifteen acres; grain, wheat predominating, sixty-five acres. There are comparatively few eighty-acre farms, larger sizes prevailing.

A special feature of the district is large ownerships and the renting the land to tenants on shares. For instance, ex-Governor B. H. Eaton owns 15,000 acres of which 12,000 acres are under cultivation,

while his two sons aggregate an additional 6,000 acres, not one of the three doing any farming himself, but renting his land out to the actual cultivators on shares. The owner furnishes the land, irrigating water, house and other improvements, receiving as rent one-third of the grain and potatoes, one-fourth of the sugar beets, one-half of the alfalfa. The tenant furnishes the implements, working animals and the labor, taking the remainder of each crop as his share. This gives the tenants a chance, which many of them would not otherwise have. A limited capital will purchase seed and horses, and hire machinery, with the certainty of getting two-thirds of the grain and potatoes, three-fourths of the sugar beets, and one-half of the alfalfa raised, while in the event of a bad year or poor crop the tenant farmer is not expected to find a certain amount of cash for a fixed rent, whether he has made it or not. In fact, it is a partnership which works well for both land owner and tenant, is equitable and has enabled many a man to make a start which he could not have done in any other way.

### **The Eaton Sugar Company.**

The Eaton district during the past season raised about 150,000 bushels of wheat and about 1,500 cars, or 22,500 tons, of potatoes, netting the growers, at \$210 per car, \$315,000.

In 1802, the Eaton Sugar company built and completed a beet sugar factory at Eaton, with a daily capacity of 600 tons of beets.

The officers of the company are: C. S. Morey, president; W. D. Hoover, vice-president; M. D. Thacher, treasurer, and W. A. Dixon, secretary.

The factory as it stands to-day, including first cost and subsequent additions and improvements, represents a cash investment of \$750,000.

The factory premises comprise sixty acres and the site is advantageous. In general matters it sufficiently resembles the other factories in Colorado as not to call for any detailed description here.

In 1902, its first season, the factory sliced 35,000 tons of beets, paying the farmers therefor at the rate of \$5 per ton, \$175,000.

For the season of 1903 it is estimated the factory will slice 60,000 tons of beets, paying the farmers therefor, at the rate of \$5 per ton, \$300,000.

### **Hundreds of Growers**

In the season of 1903 there were about 6,000 acres of beets contracted for the factory, mostly grown within a radius of eight or ten miles from the factory, the company having two dumping stations on the Union Pacific railroad, north of Greeley, viz., one at Lucerne, and the other at Ault. This factory has also received beets from the districts south of Greeley. About 65 per cent. of the beets come by wagon from the farms within three to four miles, and the other 35 per cent. come railroad.

There were about 400 individual growers last year, who averaged about fourteen acres each, the average yield being upwards of twelve tons per acre. There were instances where growers raised as much as thirty-six tons per acre, and in some cases of small tracts, receiving special attention, even as high as forty tons per acre.

The local cost of beet production ranges from \$30 to \$35 per acre.

In 1902 the payroll of the factory during the four months' sugar making season was about \$40,000, and during the eight months while the factory was idle, about \$25,000.

In 1903, the payroll of the factory during the sugar making season, commencing October 1 and finishing January 10, is expected to be \$50,000, and during the remainder of the fiscal year \$25,000.

### **Fortunes Paid Out**

The beet pulp residue from this factory, amounting to about 30,000 tons this season, is sold at 30 cents per ton at the silo, and is being used, along with hay, etc., for the feeding of 30,000 sheep within moderate radius of the factory. At the time of the writer's visit, December 21, there were said to be about 12,000 sheep in feeding pens adjoining the factory.

Having regard to the fact that the Eaton beet sugar factory represents a cash investment of \$750,000, and in its two seasons' operations has practically already paid \$475,000 for beets and \$140,000 in payrolls, or a total local disbursement in two years of about \$615,000, to say nothing of cost of coal, lime rock, railroad freight, taxes, etc., the writer was unprepared for the statement from a prominent Eaton man that there was considerable local prejudice against the beet grow-

ing, as beets are supposed to impoverish the soil. It is surprising how people, who could be expected to know better, jump to unwarranted conclusions, without first making some careful investigation. Yet here is a local example of beets as compared with potatoes and showing that beets improve the soil for other crops.

### **Some Good Returns**

Mr. William Stanley of Lucerne, grew for the Eaton sugar factory in 1903, on rented ground, belonging to a Greeley merchant, twenty acres of beets, which yielded 483 tons, for which he was paid by the factory \$2,415.

After deducting \$200 paid for bunching, thinning, and hoeing, \$241.50 for pulling and topping, and \$805 (the value of the land owner's share of the crop) for rent, he had left a net balance of \$1,168.50, or \$58.42 net per acre.

During the same season, 1903, he grew on the same farm thirty acres of potatoes, yielding 2,950 sacks, which he says will shrink in weight by the time they are sold to 290,000 pounds. If sold at present price of 80 cents per 100 pounds, they will realize \$2,320. From that amount he deducts picking, \$147.50; sacks, \$60; twine, \$3; taking out of "dug-out," \$58; or a total of \$268.50, which, added to \$1,160 (the value of the land owner's share of the crop) for rent, makes his expenses \$1,428.50, leaving him \$891.50 net for the thirty acres of potatoes, or \$29.71 net per acre, as compared with \$58.42 per acre for his beets.

### **How One Man Was Paid**

In the above comparison there is no mention of the cost of irrigating, cultivating, digging, etc., as Mr. Stanley says those items are about the same in beets as in potatoes, but if anything rather in favor of the beets; as beets can be dug with two horses, while four are required for digging potatoes.

In 1902 Mr. Stanley had a certain thirty acres of which five acres were in beets, yielding twenty tons per acre, and the other twenty-five acres being in wheat, which, however, was destroyed by hail June 27, did not yield an ounce of wheat, though irrigated, and therefore remained practically fallow in 1902. Of this same thirty acres, in 1903 he planted the five acres in potatoes which had been in beets in 1902,

and they yielded 655 sacks, or 131 sacks per acre. The other twenty-five acres which had been in wheat in 1902 he also planted with potatoes in 1903, and they yielded 2,295, sacks, or an average of 91.8 sacks per acre, as compared with 131 sacks per acre on the five acres which had previously grown beets. Mr. Stanley's experience is by no means an isolated case.

### **Industry Yet New**

The sugar beet industry in Colorado is too new for Colorado people yet to know all about it, and Colorado can learn much from Germany, where the industry has been long established and has been largely brought down to scientific principles.

Report No. 74 (page 149) of the United States Department of Agriculture says that the influence of beet culture on the farmer's land is best shown by reproducing that portion of the report of one of the United States consuls in Germany, which treats of the effects of beet culture in rotation with other crops. The Germans are not only exceedingly systematic, but very scientific, and the following report of exhaustive experiments most carefully made, should serve to undeceive any who erroneously believe that sugar beets rapidly exhaust the soil.

The United States Consul's report is as follows:

### **Some German Figures**

"A German farm of 625 acres produced, before the introduction of beet culture, yearly 9,736 bushels of grain in ten years' average. After beet culture was introduced, with 125 acres yearly to beets, the average yearly grain crop from the remaining 500 acres was 9,870 bushels, or 134 bushels' increase. Another farm in the province of Saxony, also of 625 acres, produced, before beet culture was introduced, in ten years' average, 13,879 bushels of grain. When five years afterwards 135 acres were planted with beets, the grain crop of the remaining 490 acres was 14,365 bushels' average, and afterwards, when yearly 220 acres of beets were planted, the average grain crop from the remaining 405 acres was 14,397 bushels, or 518 bushels more than from the whole 625 acres before beets were raised."

The figures of thirty-five other farms of from 500 to 1,000 acres each, in the province of Saxony, are given on page 150 of Report No.

74, the average beet crop on which was 17 1-5 tons per acre, and showing that, in consequence of growing sugar beets in rotation with other crops, the average yield of the other crops was increased as follows: Wheat, 24 per cent.; rye, 14.8 per cent.; barley, 25.2 per cent.; oats, 41.5 per cent.; peas, 86 per cent.; potatoes, 103.2 per cent.

### **Should Study Subject**

In the light of the experience of Germany, it is evident that the farmers in Montana, who desire to materially increase the average of their crops of wheat, oats, potatoes, etc., cannot do better than grow sugar beets in rotation with such other crops.

On this subject, Report No. 74 of the United States Department of Agriculture says that the above quoted German demonstration "shows that the farmer who rotates his beets with other crops does not decrease the productiveness of his land, when sown to other crops, but, on the contrary, greatly increases its productiveness. The truth is that a good farmer cannot measure his profits by his beet crop alone, but must consider the extra profit which beet culture enables him to make on everything else he grows."

The individual beet growers of Montana would do well to study the valuable information contained in the before mentioned Report No. 74, as they would thereby avoid being misled by the prejudiced statements of practically irresponsible persons, who have evidently given insufficient study to the subject.

## Report of Crop of 1903.

### TABLE OF COMPOSITION, YIELD AND VALUE

Laboratory No.	Co-operating Farmer	Locality	Date Analyzed
2499	H. O. C. Andrews	McLeod, Sweet Grass Co.	Sept. 21
2500	I. D. O'Donnell	Billings, Yellowstone Co.	" 21
2501	H. Shrammeck	Cascade, Cascade Co.	" 22
2502	C. H. Norton	Bridger, Carbon Co.	" 22
2503	J. R. Stevens	" " "	" 22
2504	G. F. Hunter	" " "	" 23
2505	J. R. Stevens	" " "	" 23
2506	A. Anderson	Feeley, Silver Bow Co.	" 23
2507	C. R. Schurch	Deer Lodge, Powell Co.	" 26
2508	M. Flannigan	Billings, Yellowstone Co.	" 28
2515	Chas. E. Coleman	Missoula, Missoula Co.	" 28
2516	Daniel Payne	Monarch, Cascade Co.	" 30
2517	H. Buckhouse	Missoula, Missoula Co.	" 30
2518	Jas. Largent	Ulm, Cascade Co.	" 30
2525	H. O. C. Andrews	McLeod, Sweet Grass Co.	Oct. 3
2532	Theodore Koenig	Kalispell, Flathead Co.	" 14
2539	N. D. Root	Whitehall, Jefferson Co.	" 14
2547	J. A. Conrey	Cascade, Cascade Co.	" 24
2550	H. Shrammeck	" " "	" 24
2551	J. B. Taylor	" " "	" 28
2552	Toman Bros.	" " "	" 28
2553	J. R. Stevens	Bridger, Carbon Co.	" 29
2554	C. R. Schurch	Deer Lodge, Powell Co.	" 29
2555	J. R. Stevens	Bridger, Carbon Co.	" 29
2562	P. W. Bradford	Great Falls, Cascade Co.	" 31
2563	A. Anderson	Feeley, Silver Bow Co.	Nov. 1
2564	Jos. L. Sargent	Ulm, Cascade Co.	" 3

TABLE OF COMPOSITION, YIELD AND VALUE.—Continued

Laboratory No.	Average weight	Per cent. sugar in juice	Per cent. sugar in beet	Per cent. total solids in juice	Yield, tons per acre	Per cent. purity
2499	1 lb. 8 oz. ....	16.8	16.0	20		84
2500	4 lbs. ....	10.6	10.1	15.5	20	68.8
2501	1 lb. 8¼ oz. ....	9.1	8.6	14.5		62.7
2502	1 lb. 2 oz. ....	13.2	12.5	17.6		75
2503	1 lb. 5 oz. ....	8.6	8.2	13.7	10	62
2504	1 lb. 5 oz. ....	10.6	10.1	15.5	10	63.3
2505	1 lb. 0 oz. ....	9.0	8.55	13.2	10	68.2
2506	1 lb. 5.5 oz. ....	12.9	12.3	16.9	20	76.3
2507	1 lb. 2.7 oz. ....	14.0	13.3	18.8	10	74.4
2508	1 lb. 8 oz. ....	10.9	10.4	15.5		70.3
2515	1 lb. 13.2 oz. ....	15.6	14.8	18.0		86.6
2516	1 lb. 1.22 oz. ....	15.4	14.6	19.4		79.3
2517	0 lb. 6 oz. ....	11.8	11.2	14.5	4	81.3
2518	0 lb. 14.7 oz. ....	11.3	10.6	15.4		73.3
2525	1 lb. 15 oz. ....	14.4	13.7	16.8		85.7
2532	1 lb. 5 oz. ....	17.8	16.9	22.1		80.9
2539	2 lbs. 5 oz. ....	11.9	11.3	15.4	9	83.8
2547	3 lbs. 0 oz. ....	10.8	10.3	16.0		67.5
2450	2 lbs. 0.7 oz. ....	13.0	12.4	17.8		73
2551	1 lb. 3.7 oz. ....	13.8	13.1	18.7	12.2	73.7
2552	0 lb. 11 oz. ....	14.9	14.2	19.3	7	77.2
2553	1 lb. 5.5 oz. ....	13.2	12.5	18.1	10	72.9
2554	1 lb. 4.7 oz. ....	14.6	13.9	18.8	13	72.3
2555	1 lb. 6.7 oz. ....	14.0	13.3	19.3	10	72.5
2562	1 lb. 9.7 oz. ....	13.0	12.4	15.7	21	82.8
2563	1 lb. 9 oz. ....	13.5	12.8	17.6	20	76.7
2564	1 lb. 0 oz. ....	12.2	11.6	16.6		73.5
Average	1 lb. 8.5 oz. ....	12.5	11.87	17	12.5	74.2

TABLE OF CULTURE NOTES

Laboratory No.	Co-operating farmer	Soil	Date planted	Date thinned
2499	H. O. C. Andrews.....	Black loam.....	May 14.....	June 12
2500	I. D. O'Donnell.....	".....	" 15.....	" 10
2501	H. Schrammeck.....	River bottom.....	" 20.....	" 20
2502	C. H. Norton.....	".....	" 10.....	".....
2503	J. R. Stevens.....	Clay loam.....	" 24.....	June 20
2504	G. F. Hunter.....	" ".....	" 20.....	July 1
2505	J. R. Stevens.....	" ".....	" 24.....	June 20
2506	A. Anderson.....	Sandy loam.....	" 28.....	" 20
2507	C. R. Schurch.....	".....	" 14.....	July 8
2508	M. Flannigan.....	Alkali soil.....	".....	".....
2515	C. E. Coleman.....	Sandy loam.....	May 10.....	June 25
2516	D. Payne.....	Bench land.....	" 13.....	July 3
2517	H. Buckhouse.....	Gravelly black loam.....	" 25.....	June 10
2525	H. O. C. Andrews.....	Black loam.....	" 16.....	" 14
2532	T. Koenig.....	".....	" 18.....	Not thinned
2539	M. D. Root.....	Gravelly loam.....	" 15.....	June 15
2547	J. A. Conrey.....	Black sandy loam.....	June 14.....	".....
2550	H. Schrammeck.....	River bottom.....	May 20.....	June 20
2551	J. B. Taylor.....	Heavy black, some alkali.....	June 6.....	July 10
2552	Toman Bros.....	Black sandy loam.....	May 29.....	June 15
2553	J. R. Stevens.....	Clay loam.....	" 24.....	" 20
2554	C. R. Schurch.....	Black loam.....	" 14.....	July 8
2555	J. R. Stevens.....	Clay loam.....	" 24.....	June 20
2562	P. W. Bradford.....	Light sandy loam.....	" 1.....	" 15
2563	A. Anderson.....	Sandy loam.....	" 28.....	" 20

TABLE OF CULTURE NOTES.—Continued

Laboratory No.	Date harvested	Width between rows	Irrigation	Cultivation	Remarks
2499	Sept. 18	18 in.	June 20, July 25..	Plowed 8 in. deep.	Season unfavorable
2500	" 18	24 "	" 7 " 7..	" 12 " "	" "
2501	" 21	24 "	None.....	" 6 " "	" favorable
2502	" 21	.....	July 1, Aug. 1....	None.....	" "
2503	" 21	16 in.	June 10, Aug. 12, Sept. 8.....	Plowed 10 in. deep	" unfavorable, stand poor
2504	" 26	18 "	June 12, Aug. 15, Sept. 1.....	" 10 " "	Season unfavorable
2505	" 21	16 "	June 10, Aug. 12, Sept. 8.....	" 10 " "	" "
2506	" 22	18 "	June 21, July 5, July 20, Aug. 12	" 7 " "	" favorable
2507	" 25	28 "	Twice.....	" 8 " "	" fair
2508	" 28	.....	.....	.....	" unfavorable
2515	" 28	30 "	June 23, July 15, Aug. 10.....	" 8 " "	" "
2516	" 28	30 "	.....	" 8 " "	Stand excellent, season unfavorable
2517	Oct. 1	18 "	None.....	" 8 " "	Season favorable
2525	" 3	20 "	June 20, July 25..	" 8 " "	" unfavorable
2532	" 10	20 "	None.....	" 6 " "	" "
2539	" 16	20 "	July 1, Aug. 10, Aug. 15.....	" 8 " "	" "
2547	" 22	20 "	Twice.....	" 8 " "	Planted too late
2550	" 26	24 "	.....	" 8 " "	Season fair
2551	" 24	24 "	Frequent.....	.....	" "
2552	" 22	30 "	Twice.....	" 10 " "	" unfavorable
2553	" 26	16 "	June 10, Aug. 12, Sept. 8.....	" 10 " "	" fairly good
2554	" 26	28 "	Once in June.....	" 8 " "	" fair
2555	" 26	16 "	June 10, Aug. 12, Sept. 8.....	" 10 " "	" very unfavorable
2562	" 29	32 "	Not irrigated.....	" 6 " "	" fair
2563	" 29	18 "	June 21, July 5, Aug. 12.....	No subsoiling .. Plowed 7 in. deep.	" favorable

## EXPERIMENT STATION.—VARIETY TESTS.

	Lab. No.	Date Harvested.	Variety.	Average Weight.	Per Ct. Sugar in juice	Per Ct. Sugar in beet
Plat 1	2493	Sept. 19	Zehringen, No 3942.....	14.6 oz.	14.2	13.5
" 2	2494	" 19	Kleinwanzlebener .....	14.6 oz.	15.5	14.7
" 3	2495	" 19	Vilmorin .....	12.3 oz.	15.0	14.3
" 4	2496	" 19	Strandes .....	14.6 oz.	13.6	12.9
" 5	2497	" 19	Braune, No 2885.....	15.1 oz.	11.7	11.1
" 9	2498	" 19	Hoerning.....	12.6 oz.	12.4	11.8
Plat 1	2509	Sept. 26	Zehringen, No 3942.....	15.8 oz.	13.7	13.0
" 2	2510	" 26	Kleinwanzlebener .....	14.6 oz.	14.2	13.5
" 3	2511	" 26	Vilmorin .....	14.7 oz.	12.5	11.9
" 4	2512	" 26	Strandes .....	1 lb 2.3 oz.	14.5	13.8
" 5	2513	" 26	Braune, No 2885.....	1 lb	11.8	11.2
" 5	2514	" 26	Hoerning.....	1 lb 2 oz.	11.8	11.2
Plat 1	2519	Oct. 3	Zehringen, No 3942.....	1 lb 1.1 oz.	16.8	16.0
" 2	2520	" 3	Kleinwanzlebener .....	1 lb 2.6 oz.	17.0	16.2
" 3	2521	" 3	Vilmorin .....	15.5 oz.	15.4	14.6
" 4	2522	" 3	Strandes .....	15 oz.	14.6	13.9
" 5	2523	" 3	Braune, No 2885.....	14.8 oz.	13.1	12.5
" 6	2524	" 3	Hoerning.....	1 lb 3.1 oz.	13.4	12.6
Plat 1	2526	Oct. 10	Zehringen, No 3942.....	14 oz.	17.2	16.3
" 2	2527	" 10	Kleinwanzlebener .....	1 lb 2 oz.	15.7	14.9
" 3	2528	" 10	Vilmorin .....	1 lb 3 oz.	14.9	14.2
" 4	2529	" 10	Strandes .....	1 lb	16.4	15.6
" 5	2530	" 10	Braune, No 2885.....	15 oz.	14.7	14.0
" 6	2531	" 10	Hoerning.....	1 lb 0.3 oz.	15.5	14.7
Plat 1	2533	Oct. 17	Zehringen, No 3942.....	12.3 oz.	20.1	19.1
" 2	2534	" 17	Kleinwanzlebener .....	1 lb 0.6 oz.	17.1	16.3
" 3	2535	" 17	Vilmorin .....	1 lb	17.0	16.2
" 4	2536	" 17	Strandes .....	1 lb 0.6 oz.	17.3	16.4
" 5	2537	" 17	Braune, No 2888.....	1 lb 1.0 oz.	14.6	13.9
" 6	2538	" 17	Hoerning.....	1 lb 3 oz.	15.5	14.7
Plat 1	2541	Oct. 24	Zehringen, No 3942.....	1 lb 3 oz.	18.5	17.6
" 2	2542	" 24	Kleinwanzlebener .....	1 lb 3.6 oz.	18.4	17.5
" 3	2543	" 24	Vilmorin .....	1 lb 3.0 oz.	17.7	16.8
" 4	2544	" 24	Strandes .....	1 lb 2.8 oz.	15.8	15.0
" 5	2545	" 24	Braune, No 2885.....	1 lb 3.8 oz.	15.7	14.9
" 6	2546	" 24	Hoerning.....	1 lb 11.3 oz.	14.5	13.8
Plat 1	2556	Oct. 30	Zehringen, No 3942.....	14.3 oz.	19.0	18.1
" 2	2557	" 30	Kleinwanzlebener .....	1 lb 4.5 oz.	16.8	16.0
" 3	2558	" 30	Vilmorin .....	14.3 oz.	17.9	17.0
" 4	2559	" 30	Strandes .....	13.0 oz.	17.8	16.9
" 5	2560	" 30	Braune, No 2885.....	12.7 oz.	16.5	15.7
" 6	2561	" 30	Hoerning.....	1 lb 3.7 oz.	16.1	15.3

## EXPERIMENT STATION—Variety Tests Continued.

	Laby. No.	Per Ct. Total Solids in Juice	Purity.
	2493	17.9	79.3
	2494	18.9	82.
	2495	18.5	81.1
	2496	18.0	75.6
	2497	15.3	77.1
	2498	17.8	69.7
	2509	17.1	80.1
	2510	17.7	80.2
	2511	16.1	71.4
	2512	18.1	80.1
	2513	15.3	77.1
	2514	15.5	76.1
	2519	20.1	83.6
	2520	20.3	83.7
	2521	19.5	79.
	2522	18.0	81.1
	2523	16.9	77.5
	2524	16.9	79.3
	2526	21.1	81.
	2527	20.1	78.1
	2528	18.3	81.4
	2529	19.9	82.4
	2530	18.2	80.8
	2531	18.8	82.4
	2533	22.7	88.1
	2534	20.1	85.1
	2535	19.7	86.3
	2536	19.8	87.3
	2537	18.1	80.6
	2538	18.4	84.2
	2541	21.7	85.2
	2542	21.4	85.9
	2543	21.2	83.5
	2544	19.0	83.2
	2545	19.0	82.6
	2546	17.9	81.0
	2556	21.3	89.2
	2557	19.4	86.6
	2558	20.9	85.6
	2559	20.8	85.6
	2560	20.2	81.6
	2561	19.4	82.9

## VARIETY TESTS. EXPERIMENT STATION. CULTURE NOTES.

	Variety	Planted	Irrigated	Thinned	Yield
Plat 1	Zehringen, No. 3942.....	May 26	July 3 and 4 about 3 in. deep; Aug. 1, 2 in. deep ....	June 1 and 15	Stand very good, 1872 lbs.
" 2	Kleinwanzlebener.	" 26	July 5 and 4 about 3 in. deep; Aug. 1, 2 in. deep ....	June 1 and 15	1992 lbs., stand very good
" 3	Vilmorin .....	" 29	July 3 and 4 about 3 in. deep; Aug. 1, about 2 in. deep	June 1 and 15	1632 lbs., stand only fair
" 4	Strandes Kleinwanzlebener ...	" 29	July 3 and 4 about 3 in. deep; Aug. 1, about 2 in. deep	June 1 and 15	1368 lbs., stand only fair
" 5	Braune, No. 2885..	" 29	July 3 and 4 about 3 in. deep; Aug. 1, about 2 in. deep	June 1 and 15	892 lbs., stand only fair
" 6	Hoerning improved Kleinwanzlebener .....	" 29	July 3 and 4 about 3 in. deep; Aug. 1, about 2 in. deep	June 1 and 15	1392 lbs., stand only fair

## EXPERIMENT STATION TESTS

Effects of Degree of Maturity on Weight, Richness and Purity of Beets. All Varieties Averaged Together

Date harvested	Average weight	Average per cent. sugar in juice	Average per cent. sugar in beets	Average of total solids in juice	Average purity, per cent.
Sept. 19 ....	13.9 oz .....	13.7 .....	13.0 oz .....	17.7 .....	77.4 .....
" 26 .....	16.2 " .....	13.1 .....	12.4 " .....	16.6 .....	77.5 .....
Oct. 3 .....	16.6 " .....	15.0 .....	14.3 " .....	18.6 .....	80.7 .....
" 10 .....	16.4 " .....	15.7 .....	14.9 " .....	19.4 .....	81.0 .....
" 17 .....	16.3 " .....	16.9 .....	15.9 " .....	19.8 .....	85.3 .....
" 24 .....	20.4 " .....	16.7 .....	15.8 " .....	20.0 .....	83.6 .....
" 30 .....	15.7 " .....	17.3 .....	16.4 " .....	20.3 .....	85.3 .....

## EXPERIMENT STATION. VARIETY TESTS. VARIETY AVERAGES.

Date harvested	Average weight	Average per cent. sugar in juice	Average per cent. sugar in beets	Average of total solids in juice	Average purity, per cent.
<b>Zehringen, No. 3942</b>					
Sept. 19.....	14.6 oz.....	14.2 .....	13.5 .....	17.9 .....	79.3 .....
" 26.....	15.8 " .....	13.7 .....	13.0 .....	17.1 .....	80.1 .....
Oct. 3.....	17.1 " .....	16.8 .....	16.0 .....	20.1 .....	83.6 .....
" 10.....	14.0 " .....	17.2 .....	16.3 .....	21.1 .....	81 .....
" 17.....	12.3 " .....	20.1 .....	19.1 .....	22.7 .....	88.1 .....
" 24.....	19.0 " .....	18.5 .....	17.6 .....	21.7 .....	85.2 .....
" 30.....	14.3 " .....	19.1 .....	18.1 .....	21.3 .....	89.2 .....
Totals.....	107.1 oz.....	119.6 .....	113.6 .....	141.9 .....	586.5 .....
Averages..	15.3 " .....	17.1 .....	16.2 .....	20.2 .....	83.8 .....
<b>Kleinwanzlebener</b>					
Sept. 19.....	14.6 oz.....	15.5 .....	14.7 .....	18.9 .....	82 .....
" 26.....	14.6 " .....	14.2 .....	13.5 .....	17.7 .....	80.2 .....
Oct. 3.....	18.6 " .....	17.0 .....	16.2 .....	20.3 .....	83.7 .....
" 10.....	18. " .....	15.7 .....	14.9 .....	20.1 .....	78.1 .....
" 17.....	16.6 " .....	17.1 .....	16.3 .....	20.1 .....	85.1 .....
" 24.....	19.6 " .....	18.4 .....	17.5 .....	21.4 .....	85.9 .....
" 30.....	20.51 " .....	16.8 .....	16.0 .....	19.4 .....	86.6 .....
Totals.....	122.5 oz.....	114.7 .....	109.1 .....	137.9 .....	581.6 .....
Averages..	17.5 " .....	16.4 .....	15.6 .....	19.7 .....	83.1 .....
<b>Vilmorin</b>					
Sept. 19.....	12.3 oz.....	15 .....	14.3 .....	18.5 .....	81.1 .....
" 26.....	14.7 " .....	12.5 .....	11.9 .....	16.1 .....	71.4 .....
Oct. 3.....	15.5 " .....	15.4 .....	14.6 .....	19.5 .....	79.0 .....
" 10.....	19. " .....	14.9 .....	14.2 .....	18.3 .....	81.4 .....
" 17.....	16. " .....	17 .....	16.2 .....	19.7 .....	86.3 .....
" 24.....	19. " .....	17.7 .....	16.8 .....	21.2 .....	86.5 .....
" 30.....	14.3 " .....	17.9 .....	17.0 .....	20.9 .....	85.6 .....
Totals.....	110.8 oz.....	110.4 .....	105.0 .....	134.2 .....	568.3 .....
Averages..	15.8 " .....	15.8 .....	15.0 .....	19.2 .....	81.2 .....

## VARIETY AVERAGES.—Concluded.

Date harvested	Average weight	Average per cent. sugar in juice	Average per cent. sugar in beets	Average of total solids in juice	Average purity, per cent.
<b>Strandes</b>					
Sept. 19.....	14.6 oz.....	13.6.....	12.9.....	18.....	75.6.....
" 28.....	18.3 ".....	14.5.....	13.8.....	18.1.....	80.1.....
Oct. 3.....	15.0 ".....	14.6.....	13.9.....	18.0.....	81.1.....
" 10.....	16.0 ".....	16.4.....	15.6.....	19.9.....	82.4.....
" 17.....	16.6 ".....	17.3.....	16.4.....	19.8.....	87.3.....
" 24.....	18.8 ".....	15.8.....	15.0.....	19.0.....	83.2.....
" 30.....	13.0 ".....	17.8.....	16.9.....	20.8.....	85.6.....
Totals.....	112.3 oz.....	110.0.....	104.5.....	133.6.....	575.3.....
Averages..	16.0 ".....	15.7.....	14.9.....	19.1.....	82.2.....
<b>Braune, No. 2885</b>					
Sept. 19.....	15.1 oz.....	11.7.....	11.1.....	15.3.....	77.1.....
" 26.....	16. ".....	11.8.....	11.2.....	15.3.....	77.1.....
Oct. 3.....	14.8 ".....	13.1.....	12.5.....	16.9.....	77.5.....
" 10.....	15. ".....	14.7.....	14.0.....	18.2.....	80.8.....
" 17.....	17. ".....	14.6.....	13.9.....	18.1.....	80.6.....
" 24.....	18.8 ".....	15.7.....	14.9.....	19.0.....	82.6.....
" 30.....	12.7 ".....	16.5.....	15.7.....	20.2.....	82.9.....
Totals.....	109.4 oz.....	98.1.....	93.3.....	123.0.....	558.6.....
Averages..	15.6 ".....	14.0.....	13.3.....	17.6.....	79.8.....
<b>Hoerning</b>					
Sept. 19.....	12.6 oz.....	12.4.....	11.8.....	17.8.....	69.7.....
" 26.....	18. ".....	11.8.....	11.2.....	15.5.....	76.1.....
Oct. 3.....	19.1 ".....	13.4.....	12.6.....	16.9.....	79.3.....
" 10.....	16.3 ".....	15.5.....	14.7.....	18.8.....	82.4.....
" 17.....	19. ".....	15.5.....	14.7.....	18.4.....	84.2.....
" 24.....	27.3 ".....	14.5.....	13.8.....	17.9.....	81.0.....
" 30.....	19.7 ".....	16.1.....	15.3.....	19.4.....	81.9.....
Totals.....	132.0 oz.....	99.2.....	94.1.....	124.7.....	559.6.....
Averages..	18.8 ".....	14.2.....	13.4.....	17.8.....	80.0.....

## EXPERIMENT STATION. VARIETY TESTS.—Season of 1901.

Laboratory No.	Variety	Average weight, oz.	Sugar in juice	Sugar in beet	Purity Coef.	Date harvested
1806	Miscellaneous . . . . .	20.00	16.8	15.96	84.44	Sept. 19
1831	Kleinwanzlebener, No. 5770 . . . . .	24.8	15.8	15.3	81.00	" 28
1832	Utah Seed . . . . .	25.4	16.5	15.87	85.5	" 28
1833	Zehringen, No. 3942 . . . . .	16.8	15.6	14.82	88.2	" 28
1834	Braune, No. 2885 . . . . .	23.00	16.1	15.19	83.3	" 28
1835	Kleinwanzlebener Dippe, No. 3944 . . . . .	19.6	16.3	15.58	82.02	" 28
1836	Kleinwanzlebener Russia, No. 3943 . . . . .	23.4	15.00	14.25	78.00	" 28
1837	Vilmorin . . . . .	20.2	15.8	15.01	79.7	" 28
1838	Unknown variety . . . . .	20.4	16.6	15.77	85.5	" 28
1842	Kleinwanzlebener, No. 5770 . . . . .	20.5	16.1	15.29	76.3	Oct. 5
1843	Utah Seed . . . . .	21.00	17.9	17.00	87.5	" 5
1844	Zehringen, No. 3942 . . . . .	22.00	15.9	15.10	74.6	" 5
1845	Braune, No. 2885 . . . . .	20.00	17.7	16.71	82.3	" 5
1848	Kleinwanzlebener Dippe, No. 3944 . . . . .	19.00	19.5	18.52	88.6	" 5
1847	Kleinwanzlebener Russia, No. 3943 . . . . .	18.00	17.6	16.72	86.1	" 5
1848	Vilmorin . . . . .	26.5	14.00	13.3	72.9	" 5
1869	Kleinwanzlebener, No. 5770 . . . . .	25.5	17.0	16.15	86.00	" 12
1870	Utah . . . . .	17.00	18.5	17.57	84.9	" 12
1871	Zehringen, No. 3942 . . . . .	15.5	18.3	17.38	83.3	" 12
1872	Braune, No. 2885 . . . . .	16.5	18.5	17.57	86.3	" 12
1873	Kleinwanzlebener Dippe, No. 3944 . . . . .	14.00	19.1	18.14	90.5	" 12
1874	Kleinwanzlebener Russia, No. 3943 . . . . .	14.5	18.6	17.67	88.5	" 12
1875	Vilmorin . . . . .	17.00	19.2	18.24	87.6	" 12
1882	Kleinwanzlebener, No. 5770 . . . . .	15.00	18.4	17.48	82.9	" 19
1883	Utah . . . . .	18.00	19.3	18.33	86.1	" 19
1884	Zehringen, No. 3942 . . . . .	14.66	20.00	19.00	87.00	" 19
1885	Braune, No. 2885 . . . . .	16.66	19.9	18.9	87.6	" 19
1886	Kleinwanzlebener Dippe, No. 3944 . . . . .	18.66	18.3	17.38	85.9	" 19
1887	Kleinwanzlebener Russia, No. 3943 . . . . .	14.66	18.2	17.29	86.6	" 19
1888	Vilmorin . . . . .	17.00	17.9	17.00	84.00	" 19
1966	Kleinwanzlebener, No. 5770 . . . . .	20.8	17.90	17.00	81.8	" 26
1967	Utah . . . . .	17.4	20.10	19.05	85.00	" 26
1968	Zehringen, No. 3942 . . . . .	20.00	19.70	18.78	85.5	" 26
1969	Braune, No. 2885 . . . . .	21.00	19.70	18.74	87.00	" 26
1970	Kleinwanzlebener Dippe, No. 3944 . . . . .	23.00	19.50	18.46	88.00	" 26
1971	Kleinwanzlebener Russia, No. 3943 . . . . .	19.00	19.30	18.35	87.5	" 26
1972	Vilmorin . . . . .	22.00	17.97	17.01	86.00	" 26

## AVERAGES OF ALL TESTS. EXPERIMENT STATION.—Season of 1901

Variety	Average weight, oz.	Sugar in juice, per cent.	Sugar in beet, per cent.	Purity Coef.	Tons per acre	Lbs. sugar per acre
Kleinwanzlebener, No. 5770 .....	21.32	17.04	16.31	81.6	13.5	4403
Utah .....	19.76	18.44	17.51	85.8	11.7	4007
Zehringen, No. 3942 .....	17.8	17.91	17.01	83.7	11.45	3896
Braune, No. 2885 .....	19.43	18.38	17.42	85.3	10.5	3658
Kleinwanzlebener Dippe, No. 3944 .....	18.85	18.53	17.61	87.00	10.4	3662
Kleinwanzlebener Russia, No. 3943 .....	17.91	17.75	16.85	85.3	9.25	3117
Vilmoria .....	20.5	17.13	16.27	84.00	9.5	3091
General average .....	19.37	17.88	16.98	84.9	10.9	3690

## AVERAGES FOR SUCCESSIVE DATES. EXPERIMENT STATION.—

Season of 1901

Date	Average weight	Per cent. sugar in juice	Per cent. sugar in beet	Per cent. purity
Sept. 28 .....	21.7 oz	15.96	15.20	82.90
October 5 .....	21.0 "	16.96	16.13	81.19
" 12 .....	17.14 "	18.46	17.53	86.73
" 19 .....	16.38 "	18.86	17.92	85.73
" 26 .....	20.45 "	19.18	18.25	85.83

## RESULTS IN 1901.—CLARK'S FORK VALLEY.—BRIDGER AND GEBO.

The \* indicates that the P. O. address is Gebo; the address of all others is Bridger.

Laboratory No.	Name	Average weight in oz.	Sugar in juice	Sugar in beet-	Purity Coef.	Tons beets per acre	Lbs. sugar per acre
1850	P. R. Miller*	8.8	17.1	16.22	79.9	6.5	2108
1854	C. F. Sexton	29.00	15.9	15.10	80.3	25.00	7552
1881	A. E. Parker	31.5	14.3	13.58	69.4	9.00	2444
1889	William Barclay	14.7	16.2	15.39	78.2	12.00	3695
1891	James Barclay	19.43	21.3	20.23	82.88	20.00	8092
1903	C. M. Larkin	10.8	16.88	16.00	80.00	.....	.....
1907	W. H. Bostic	24.9	19.5	18.52	78.3	20.00	7408
1934	C. H. Bostic	9.4	15.5	14.72	67.1	.....	.....
1935	W. F. Gibson	35.5	18.00	17.1	74.4	24.00	8208
1936	Lucy H. Smith	28.00	20.1	19.09	83.7	20.00	7636
1937	Hugh Morrow	26.5	19.7	18.71	74.5	15.00	5613
1938	R. B. Teesdale	.....	18.8	17.86	85.4	25.00	8930
1939	E. T. Bostic	28.50	21.9	20.8	88.3	.....	.....
1940	J. R. Stevens	55.0	14.81	14.06	77.4	15.00	4218
1941	S. H. Mendenhall	14.8	18.11	17.2	83.8	20.00	6880
1942	Thomas Barnett	20.8	16.5	15.67	80.00	12.00	3760
1943	A. G. Duffield	32.00	17.8	16.9	83.00	25.00	8450
1944	L. G. Preno	24.5	17.9	17.00	79.6	20.00	6800
1945	F. O. Jennings	31.00	17.6	16.7	75.00	.....	.....
1946	B. F. Bayler	33.00	22.7	21.56	85.3	.....	.....
1947	Richard Barrows	25.5	18.6	17.67	82.00	20.00	7068
1952	I. A. Goff *	11.6	13.4	12.73	74.44	12.00	3055
1953	F. E. Stevens	21.00	16.00	15.20	82.05	25.00	7600
1954	Frank Hiser	9.2	19.3	18.33	84.65	15.00	5499
1955	E. D. Lovegreen	14.33	16.3	15.48	77.94	15.00	4644
1956	E. T. Preuitt	18.66	19.1	18.14	86.80	20.00	7256
1957	W. A. Cowan*	21.00	16.8	15.96	80.00	.....	.....
1958	E. Cowan	15.4	19.8	18.81	90.00	20.00	7524
1959	N. Webber	18.6	18.7	17.76	86.12	.....	.....
1960	C. M. Laughery	17.5	19.9	18.90	88.83	20.00	7560
1961	T. E. Stearns	18.66	14.7	13.96	76.96	.....	.....
1960	R. A. Duncan †	25.00	17.7	16.8	80.00	.....	.....

† P. O. address is Rockvale.

**RESULTS IN 1901.—BITTER ROOT STOCK FARM.—HAMILTON,  
MONTANA**

Laboratory No.	Locality	Average weight in oz.	Sugar in juice	Sugar in beet	Purity Coef.	Tons beets per acre	Lbs. sugar per acre
1855	Hamilton Ranch, No. 1.....	17.8	20.1	19.09	87.3	18.9	7216
1856	Hamilton Ranch, No. 2.....	16.6	19.3	18.33	86.9	13.6	4965
1857	Hamilton Ranch, No. 3.....	15.2	20.1	19.9	82.4	22.00	8756
1858	Hamilton Ranch, No. 4.....	8.8	21.1	20.04	87.5	12.7	5060
1859	Gilchrist Ranch, No. 1.....	11.00	20.6	19.57	88.4	18.4	7201
1860	Gilchrist Ranch, No. 2.....	11.6	22.00	20.9	91.2	.....	.....
1861	Prendergast Ranch, No. 1.....	11.8	19.8	18.81	87.6	20.00	7524
1862	Prendergast Ranch, No. 2.....	13.6	22.1	20.99	92.00	18.00	7556
1863	Lower Ward Ranch, No. 1.....	13.00	21.1	20.04	90.6	18.3	7334
1864	Lower Ward Ranch, No. 2.....	12.4	20.8	19.76	89.2	14.00	5532
1865	Upper Ward Ranch, No. 1.....	13.4	20.3	19.28	87.5	12.00	4627
1866	Ravalli Ranch.....	13.00	20.2	19.19	90.00	14.6	5603
1867	Corvallis Ranch.....	15.6	20.4	19.38	86.4	25.6	9922

**LOCALITY AVERAGES FOR 1901**

Locality	Average weight in oz.	Sugar in juice	Sugar in beet	Purity Coef.	Tons beets per acre	Lbs. sugar per acre
Cascade County (1).....	24.5	16.25	15.4	75.4	25.00	8075
Yellowstone County.....	35.66	10.50	10.00	62.6	.....	.....
Flathead County.....	16.45	18.9	17.95	82.24	12.8	4520
Valley County (1).....	19.40	15.2	14.43	82.7	20.00	5968
Park County (2).....	19.5	16.66	15.94	73.07	20.5	6498
Custer County (1).....	16.00	18.4	17.5	79.00	.....	.....
Dawson County (1).....	18.6	14.00	13.3	76.5	.....	.....
Powell County.....	21.9	15.6	14.86	81.8	.....	.....
Fergus County.....	17.00	15.4	14.63	71.6	23.00	7552
Jefferson County.....	23.00	13.50	12.82	83.00	.....	.....
Carbon County (3).....	29.2	13.9	13.2	66.5	16.00	4244
Missoula County.....	16.7	17.3	16.46	83.00	13.00	4288
Ravalli County (4).....	16.8	17.8	16.96	82.45	.....	.....
Gallatin County (5).....	22.88	15.46	14.68	78.9	31.00	9332
Bitter Root Stock Farm.....	13.37	20.60	19.64	87.46	16.5	6771
Experiment Farm.....	19.37	17.88	16.98	84.9	10.9	3690
Clark's Fork Valley.....	22.7	17.84	16.97	80.5	18.00	6174

- (1). One lot only.
- (2). One locality only.
- (3). Excluding Clark's Fork Valley.
- (4). Excluding Bitter Root Stock Farm.
- (5). Excluding Experiment Farm.

On the whole the results of the experiments in 1903 are unsatisfactory. This view is forced upon one after a study of the results in preceding years, especially those of the year 1901, some of which are included in this bulletin for comparison with the work of the past season.

These results are due largely to the fact that even less interest than usual has been given to the culture of beets during the past year. This lack of interest is due mainly to the fact that notwithstanding the excellent results obtained in the past, no market for beets, through the establishment of a factory in Montana, has yet been made, and in consequence beets have received but scant attention,

It is said that "figures speak for themselves," and certainly the results presented show that under proper attention Montana can hold its own as a beet sugar producing state.

With the figures presented for many years past by the Montana Experiment Station, why is it that we are not producing our own sugar?

I am indebted to "Beet Sugar Points," and to articles by Mr. Thomas Tonge for much of the matter of a general nature introduced into this bulletin, to Prof. Linfield, Agriculturist of the Station, for supervision of the variety tests, and to Mr. Edmund Burke, assistant chemist, for the analytical work on all the beets submitted.

For additional information concerning results obtained in Montana in former years, readers of this bulletin are referred to Bulletins 19, 33 and 41 of the Montana Experiment Station.

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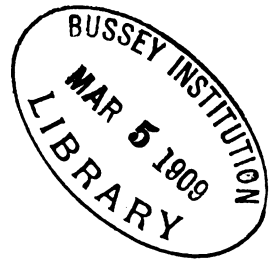
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MONTANA AGRICULTURAL COLLEGE  
EXPERIMENT STATION

F. B. LINFIELD, DIRECTOR.

BULLETIN NO. 53. ✓



**CREAMERIES AND CHEESE FACTORIES:**  
**ORGANIZATION, BUILDING AND EQUIPMENT**



*Dairy Building—Montana Experiment Station.*

BY  
**W. J. ELLIOTT,**  
*Assistant Dairyman.*

BOZEMAN, MONTANA:  
THE AVANT COURIER PUBLISHING CO.  
AUGUST, 1904.

**MONTANA AGRICULTURAL COLLEGE  
 EXPERIMENT STATION.  
 BOZEMAN, MONTANA.**

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# Montana Experiment Station.

Bulletin No. 53.

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## CREAMERIES AND CHEESE FACTORIES

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### THEIR ORGANIZATION, BUILDING AND EQUIPMENT.

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Dairying can scarcely be said to be an industry in Montana, though the natural facilities, climate, soil, water and feed, as well as the market, are very favorable indeed. Montana probably offers as good prices for dairy products as any state in the Union and very much better than most of the states, yet there are millions of pounds of butter and cheese imported into the state annually. There are probably several reasons for this. As a rule the farms in Montana are large and much hired help has to be depended upon. The successful herd requires the careful supervision of the owner which is generally possible only on the smaller farms. Montana farms are productive and her farmers have been content with the smaller returns rather than undertake the more exacting demands of dairy work. The profitable dairy herd produces milk the year round and some of the cows have to be milked 365 days in the year, morning and evening. Though the income is substantial many will not try to increase it at the cost of the extra tax on their time and attention.

That the dairy industry may be attended with marked success in Montana, there is ample evidence to prove. A dairy herd in the Gallatin valley last year returned its owner \$65 from each cow. The feed at market prices cost not to exceed \$30 for each cow. On this basis, by selling the feed to the cows the returns of the farm were more than doubled as compared to selling the crop off the farm. These returns indicate a good dairy herd, but that is the only kind with which a person should attempt the business.

## ADVANTAGES OF DAIRYING.

When we consider that the value of the dairy products in the United States amounts to the enormous sum of four hundred and fifty million dollars each year, we see at once that it is one of the largest branches of agriculture. Its advantages to those engaging in it are many. In the first place it is a cash business and also a business from which there is a little ready money coming in all the year round, which is infinitely better, both for the farmer and the merchant, than having one to two pay days a year, for instance, when the grain is threshed and drawn to market, or live stock sold. Another point is that it gives employment all the year round. Just think of the exclusive grain growing practice for a moment and note how all the work of the year is rushed into a few weeks in the hottest part of the summer, when it is almost impossible to get competent help. Right there is where the dairy industry is a boon to the farmers' sons. It gives them something that pays well for their time and employment all the year round. In other words, it keeps the farmer and his family busy. They do not need to seek employment in the city. It keeps the boy on the farm.

Another advantage of the dairy industry for Montana is that there are not long freight hauls to market. There is an unlimited market right at home, with prices for butter and cheese that excel those of almost any other state in the Union. In addition there is a fine climate, pure water, and as good feed as can be grown anywhere. All these are prime essentials for high quality butter and cheese.

One of the questions that we generally meet with is, "What is the use of starting a creamery to make more butter, when we cannot find a market for that which we are making on our ranches now?" The reason that a ready market cannot be found for the ranch butter is simply because it is hard to find any two lots of butter in a community that are exactly the same in every respect. But where all the farmers bring their cream or milk to a central plant, and have a skilled butter or cheese maker turn out a uniform article, there is not the least difficulty in disposing, right in our own state, of all the butter and cheese that fifty plants could turn out.

## CAUTION.

We do not wish for a moment to give only the bright side of the dairy industry, for there is a "work" side also. It is just like any other business. To make money out of it requires care and attention.

It requires care and selection in handling the cows, care in the feeding, care in the handling of the milk, and care over all these things for twelve months in the year.

But there is no other branch of farm work that will pay better, for the care and attention you give it, than the dairy business. Far better than selling the farm crops at the prevalent market prices, sell them through the cow and the milk pail, and you will realize just double market prices for your crop.

The creamery or cheese factory business like any other manufacturing business, requires a certain amount of raw material before the plant can be run successfully. A lack in the milk supply is perhaps the cause of more new creameries failing than any other. The first thing in starting a factory therefore is to find out if there is sufficient milk with which to keep the plant running the year round. Those interested must have an absolute guarantee of the milk from 300 cows for a creamery and 150 to 200 for a cheese factory, with prospects that this number will be increased as rapidly as possible in the near future. If the milk from about this number of cows cannot be guaranteed it will be good business to let the creamery project rest for a time. No creamery, however well equipped or managed, can make any money for its owners or patrons with but one to two thousand pounds of milk a day.

When the farmers own the plant and enter into a written contract with each other to supply the milk from the requisite number of cows, under good management the factory cannot fail to succeed.

Because of the above facts and of the large number of inquiries that are coming into the office, with reference to the building and equipping of creameries and cheese factories, it was thought advisable to prepare this bulletin, which we trust may be useful to those who are thinking of erecting such plants.

Plans and specifications are given for an up-to date creamery and cheese factory, and also complete lists of machinery for both. These plans we have found after ten years of practical work in such plants to be well adapted for the purpose, and not only that, but every article mentioned is necessary for the successful operation of either plant.

In the descriptions which follow the object has been to give clear and condensed plans and specifications, and also a complete list of machinery for an up-to-date, thoroughly equipped Lutter and cheese factory.

On the following pages will be found plans for what we consider a model creamery and cheese factory. These plans combine the best points of several creameries and cheese factories. Blue prints of these plans may be had on application to the Station.

## **ORGANIZATION OF CREAMERIES OR CHEESE FACTORIES.**

If the required number of cows are found, within the prescribed limits, the next thing is organization.

Montana, Minnesota, North and South Dakota have laws which should be followed in forming corporations. The best plan is to have some attorney draw up the necessary corporation papers, if you desire to incorporate.

The laws of the state of Montana, however, permit the organization of cooperative creameries and cheese factories without the necessity of incorporating. Any attorney can draw up the necessary agreement, or you will find elsewhere in this bulletin a copy of agreement, constitution and by-laws, that are recommended.

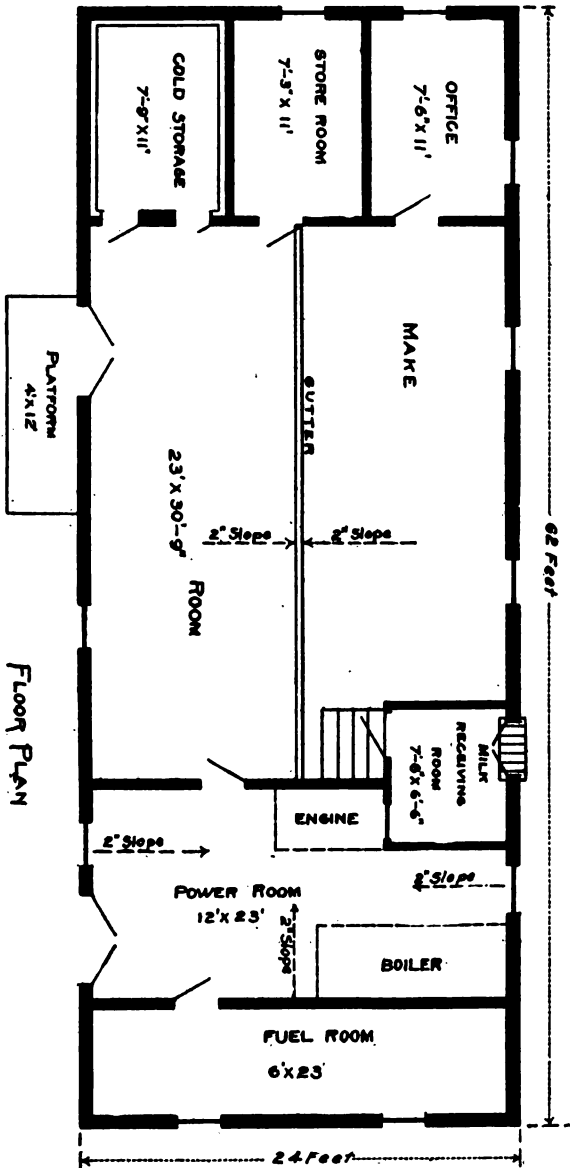
### **FORM YOUR OWN ORGANIZATION.**

By all means, however, form your own organization, and do not be led by the agent of any creamery supply house into a plan whereby he organizes you into a company, builds your creamery, equips it and turns it over to you in complete running order. This is the rock on which most of the creameries that have failed have

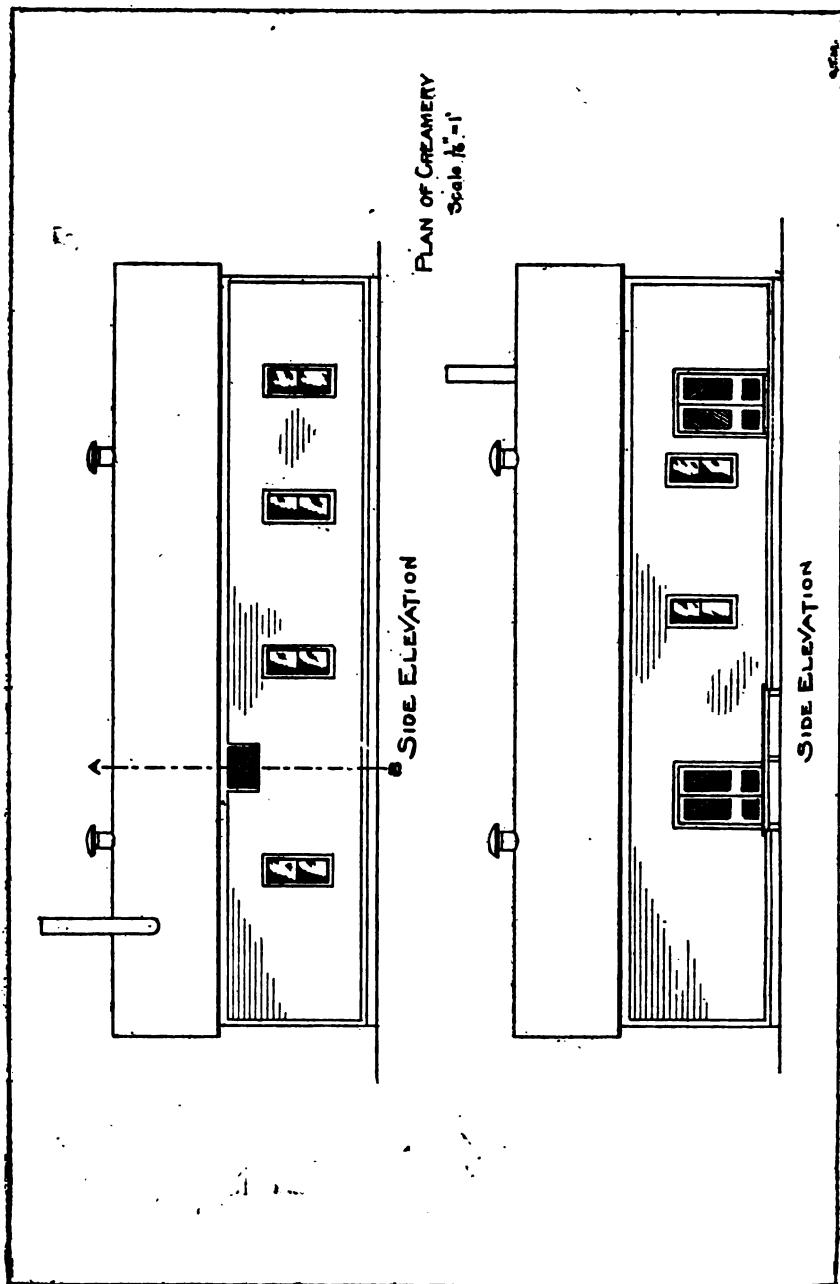
PLAN OF CREAMERY  
 RECOMMENDED BY THE DAIRY DEPARTMENT OF THE  
 MONTANA AGRICULTURAL EXPERIMENT STATION

BUILDING 62' X 24'

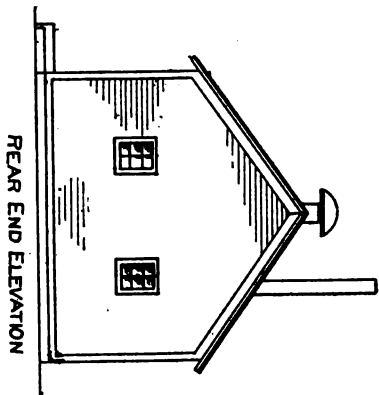
Scale  $\frac{1}{8}" = 1'$



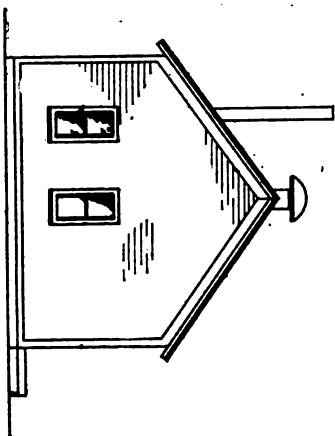
Floor Plan



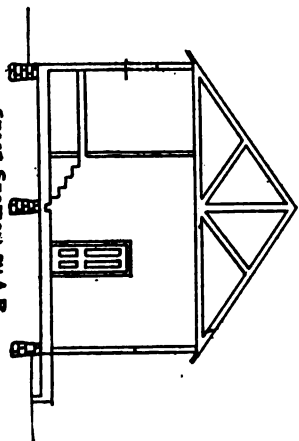
PLAN OF CREAMERY  
 Height of Ceiling 12', 3 Pitch  
 Scale 1/2" = 1'



REAR END ELEVATION



FRONT END ELEVATION



CROSS SECTION ON A-B

split. The agricultural and dairy papers have for years been teeming with exposures of this swindle of ready built creameries; but every year seems to find a new crop of people ready to bite. And the consequence is the country is dotted with expensive worthless creameries standing idle.

The leading creamery supply houses do not undertake to organize and build a creamery. Their business is to furnish the machinery only, but there are one or two houses that have agents constantly going through the country offering to work up a creamery company in any neighborhood, soliciting stock and getting up the articles of incorporation, building the creamery and equipping it and turning it over to an association of farmers at a given price.

This, of course, seems like a very nice way, as it relieves the members of the creamery association of all the preliminary work and the organization of the creamery, but you can rest assured no one is going to do this work for nothing, and no outside parties can do this as cheaply and effectively as you can do it yourselves.

When any man comes along offering to organize a creamery company, solicit stock, draw the papers, build the building, and equip it, turning it over to you a ready built creamery, and taking all the work of organization off your hands, look with suspicion upon the project. He isn't working for his health, but is doubtless drawing a big salary to do work you can just as well do yourselves. No outside company can go into a neighborhood and spend the time necessary to work up a company, build and equip a creamery, pay salaries, traveling expenses and hotel board for nothing, and they usually get a good large profit on top of the expenses made. Therefore, we repeat, *form your own organization, and build the creamery yourselves.*

Keep your business in your own hands and don't sign away your rights to organize and build your own business and give the benefit of what profit there may be in it to others.

#### HOW TO RAISE THE MONEY.

The old plan for building factories was for each patron to take one or more shares of stock, paying the cash for them. In many

instances it has been found difficult to raise the money under this plan, as many desirable patrons were unable to raise the amount of cash required to build and equip the plant.

To overcome this difficulty a plan was devised which has been used by a great many companies with very satisfactory results. This plan is as follows: Let each patron of the proposed creamery sign an agreement similar to that drawn on page 68 marked "Organization Agreement," signing his name and the number of cows he will agree to milk for the creamery or cheese factory.

You will notice this agreement provides for borrowing the amount of money necessary to build the creamery, and that each person signing the agreement agrees to be personally responsible for the payment of the sum borrowed.

There is hardly a community in the state in which some one cannot be found to loan \$2500 (cheese factory) to \$4500 (creamery) to an association of twenty-five or fifty or more, farmers each one of whom agrees to be personally responsible for the loan.

When the required number of patrons and cows have been secured, call a meeting of the patrons and perfect the organization, by adopting and signing articles of agreement.

We give on page 68 articles of agreement and by-laws which have been used in a great many creameries and cheese factories and have been found very satisfactory. Of course such changes could be made in these as might be desired.

You will notice that Article Two of the by-laws provides that 5 cents on each hundred pounds of milk received at the creamery shall be retained to form a sinking fund to be used to pay off the money borrowed, and that Article Four of the agreement authorizes the board of directors to borrow the sum required, the loan to be paid back out of the sinking fund as fast as it accumulates.

This plan enables the creamery company to start without the individual patrons being required to raise the cash; and at the same time it gives the creamery the ready cash to buy their lumber, material and machinery so as to obtain the benefit of the lowest cash prices.

The five cents per hundred pounds that is deducted from the amount of milk taken to the creamery is not felt by the patrons, as

even after this is taken out they will get more out of their milk than they have been getting by making it into butter and cheese themselves, so the creamery is gradually paying for itself without expense to the patrons.

Under this plan a creamery that is receiving milk from 300 cows should be getting six thousand pounds of milk a day; if five cents per hundred of this went into the sinking fund, it would be three dollars a day; so that it would require from two years and a half to four years to pay off the loan, and have the creamery clear under this plan, on a creamery receiving the amount of milk stated. By this means also the factory is paid for and the patron practically does not feel it at all.

We give below a draft of organization agreement, articles of agreement, and by-laws which can be used as a guide and changed or modified as desired.

### ORGANIZATION AGREEMENT.

We, the undersigned citizens of.....county, State of Montana, do hereby agree to form themselves into an association to be known by the name of..... Association, and we agree to borrow the sum of.....dollars or less, to put up a building and equip it with the necessary machinery, and jointly to become personally responsible for the sum borrowed including interest. The money to be raised in the manner agreed upon by the association. We also agree to furnish the milk from the number of cows opposite our names.

Name..... Cows.....

### ARTICLES OF INCORPORATION.

We, whose names are hereto subscribed, and whose residences are within the county of..... in the state of Montana, do hereby associate ourselves together as a cooperative association under the laws of the state of Montana, to which we have adopted the following constitution, viz.:

ARTICLE I.

The name of the association will be the.....  
Association, and its place of business shall be at or near Section....  
in the town of.....in said..... county.

ARTICLE II.

The object of this Association shall be the manufacture of  
butter and cheese or both from whole milk, at actual cost.

ARTICLE III.

The officers of this Association shall be a President, Vice President, Secretary, Treasurer and three trustees, who shall be elected annually at the regular annual meeting of the Association to be held on the first Monday of January of each year, and their term of office shall be one year and until their successors shall have been duly elected and have qualified.

ARTICLE IV.

The duties of the respective officers shall be as follows: The President shall preside at all meetings of the Association. He shall have power to call special meetings of the Association whenever in his judgment required by the business of the Association or upon the written request of five or more members.

The Vice President shall perform the duties of the President when he is absent or otherwise unable to attend to them.

The Secretary shall keep a record of all the meetings of the Association, and make and sign all orders upon the Treasurer and pay over to the Treasurer all money which comes into his possession, taking the Treasurer's receipt therefor.

The Treasurer shall receive and receipt for all moneys belonging to the Association, and pay out the same only upon orders which shall be signed by the Secretary. The Secretary and Treasurer shall give bonds in such amount as the Association shall provide.

The President, Vice President, Secretary and Treasurer and three trustees shall constitute the Board of Directors, whose duties shall be to audit and allow all just claims against the Association. They shall compute the amount of milk receipts, the amount of

product sold, and the moneys received therefor, and, after deducting from the total receipts the percentage herein provided for as a sinking fund and also the running expenses, on the 15th day of each month, divide the remaining receipts of the preceding month among the members and patrons of the Association, proportionately to the amount of whole milk or fat furnished by each. Provided, however, that in case of withdrawal of any member from this Association before the moneys herein provided to be borrowed shall have been paid in full, principal and interest, all product from milk furnished by such withdrawing members then on hand, and any moneys received from such product then in the possession of the Association, shall be retained until all said moneys so borrowed shall have been fully repaid, and thereafter said moneys, or any remainder thereof after applying the just share of such withdrawing members therefrom to the repayment of any balance of such indebtedness not paid from the sinking fund, shall be paid over to him or his assigns.

The Board of Directors shall cause the Secretary to make in writing, a report to the annual meeting of the Association, setting forth in detail the gross amount of milk receipts, the net amount of receipts from all products sold and all other receipts, the amount paid out for running expenses, the sums, if any, paid out for milk, and all other matters pertaining to the business of the Association. A like statement, containing the gross amount of milk receipts, the net receipts from products sold and all running expenses of the creamery shall be made each month and posted conspicuously in the creamery building at the time of the division of the prior month's receipts as aforesaid.

The Board of Directors shall borrow a sum of money not exceeding.....thousand dollars, to be used by them in the erection and completion and furnishing of the creamery building and for no other purpose. Said members of said board may borrow said money on their own responsibility, and in case they do so, then the sinking fund herein provided for shall by them be applied in payment of said borrowed moneys as the same fall due in the same manner as though said moneys had been borrowed by the Association. Said members of the board shall in such case be held to be

creditors of the Association to the amount of such moneys unpaid, and the several members of said Association shall be personally responsible, jointly and severally, for the same. Provided, however, that prior to any legal assertion of such individual responsibility, the entire sinking fund then accrued and on hand shall be applied upon such indebtedness. And, provided, further, that said members so borrowing said moneys may, if they so elect, demand and receive any part or all of the moneys received from the products sold then in the possession of the Association, upon such indebtedness before enforcing such personal responsibility. In which case only that part of such indebtedness remaining after applying thereon all sums so received shall be recovered or demanded from the members of the Association.

#### ARTICLE V.

The several members shall furnish all the milk from all the cows subscribed by each, all milk to be sound, fresh, unadulterated, pure and unskimmed, and patrons of the Association, not members, may by agreement with the Board of Trustees furnish such amounts of milk as may be agreed upon. The Association shall receive all such milk so furnished, manufacture the same into butter, cheese or other products, and sell and receive all moneys from the product; and from the moneys so received deduct such a percentage thereof or such a number of cents per one hundred pounds of milk as shall have been agreed upon by the Association in the by-laws or otherwise, and also deduct the running expenses of the creamery, the remainder thereof to be distributed as provided in Article IV hereof.

#### ARTICLE VI.

Each member shall be entitled to one vote only at any meeting of the Association. New members may be admitted as provided in the by-laws. Members shall be permitted to withdraw only as provided by the By-Laws.

## ARTICLE VII.

The first officers and Board of Trustees shall be as follows:

.....President;  
 .....Vice President;  
 .....Secretary;  
 .....Treasurer;  
 .....  
 .....  
 .....Trustees.

## ARTICLE VIII.

These articles may be amended at any annual meeting, or at any special meeting called for that purpose, provided that two-thirds of all members present vote in favor of such change; and provided further, that at least one month's notice of such proposed amendment shall have been given in such manner as may be provided in the By-Laws, or otherwise by the Association.

## BY-LAWS OF.....ASSOCIATION.

## I.

The Secretary and Treasurer shall give bonds in the sum of .....dollars, both bonds to be approved by the Board of Directors.

## II.

Five cents on each one hundred pounds of milk received at the creamery shall be reserved to form a sinking fund.

## III.

No milk shall be received or business of any kind transacted at the creamery on Sundays.

## IV.

During the interval between the 20th day of May and the 20th day of September of each season all milk shall be delivered at the creamery as early at least as nine o'clock a. m., during the remain-

ing portion of the season as early as ten o'clock a. m.

## V.

All milk delivered shall be sweet and in good condition; and if any be found otherwise, the operator may condemn the same, and in such case he shall notify the president thereof. The operator shall preserve samples of every delivery of each patron's milk, testing the same at proper intervals on the composite testing plan.

## VI.

Any member or patron of the Association found skimming, watering or in any manner adulterating his milk offered at the creamery shall forfeit to the Association as follows: For the first offense, ten dollars; for the second offense, twenty-five dollars; for the third offense, he or she shall forfeit all interest in the Association and also all claims for milk theretofore delivered to the Association. But no such forfeiture shall be adjudged without first affording to the member or patron charged with so having skimmed, watered or adulterated his milk, full opportunity to defend himself from such charge. Any member sending to the creamery any bloody or unhealthy milk, or any milk from any cow within four days after calving, shall, if convicted of having done so knowingly, forfeit as prescribed above in this section.

## VII.

Members and patrons furnishing whole milk may take from the separator or tank at the creamery four-fifths of the quantity of milk (in pounds or quantity) delivered at the creamery by them on that day. Any member taking therefrom more than such amount shall forfeit to the Association the sum of five dollars for each such taking.

## VIII.

Withdrawals from the Association shall be allowed only as follows: The member desiring to withdraw shall give at least one month's notice of his application therefor. Such application shall only be allowed on a vote of two-thirds of all members present and voting at any meeting or hearing at which such application shall

have been noticed. Provided, however, that any member living more than three miles by the nearest road from the creamery building, may make application to the Board of Directors, who, in their discretion, may grant permission to such member to withdraw from the Association.

#### IX.

Any member refusing to deliver at the creamery the amount agreed to be there delivered, shall, without reasons satisfactory therefor to the Association, forfeit all interest in the product on hand.

#### X.

Notice of any proposed amendment to the Constitution shall be in writing or printing and shall be kept posted prominently in the creamery building and also on the walls of the delivery department for the reception of milk.

### LOCATING A CREAMERY.

There are four things to be considered in locating a creamery:

First, there must be on an average 300 cows, milking for three hundred and sixty-five days in the year, within a paying hauling radius of the creamery, (from 6 to 8 miles on each side of the creamery).

Second, there must be pure water.

Third, there must be good drainage.

Fourth, good roads by which the patrons may reach the factory are very essential.

**GENERAL SPECIFICATIONS FOR CREAMERY.**

1. *Trenches* shall be excavated for all walls, at least 1 foot below the natural surface of the ground.

2. *Stonework.* All foundations and piers to be rubble work, consisting of sound local stone laid in lime and sand mortar mixed to proper proportions. Sand to be clean, coarse and sharp. Lime, fresh local lime. All walls to be faced on outside, slushed up and neatly pointed. All walls to be well bonded with frequent headers, and the angles tied with through stone. Stonework to be 6 inches above ground at highest point. The contractor may at his option use concrete in place of stone work, of proportions hereinafter specified for concrete work.

3. *Cement Work.* All cement used to be standard grade cement. Engine and boiler room to have concrete floors. Also concrete foundation for separator, said foundation to be started  $1\frac{1}{2}$  feet below the natural surface of ground.

The concrete will be composed of one part cement and three parts sand and five parts broken stone and gravel, tamped in place until water shows on the surface.

Top coating will consist of one part cement and two parts clean sand, free from loam, to be put on before concrete is dry. Surface to be troweled smooth. There shall be proper slope to the concrete in engine and boiler room for drainage.

5. *Carpenter Work,* All two sash windows will be  $1\frac{3}{8}$  thick, pine or fir, and free from imperfections that may impair its strength.

Building to be substantially framed together and thoroughly nailed, using nails of suitable size.

Floor joists 2x10-16 inch on centers.

Rafters 2x6-24 inch on centers.

Studding 2x4-16 inch on centers.

All partition studding to be 2x4.

Plates 2x4 double.

Ceiling joists 2x6-24 inch centers.

Truss on every third rafter 1x6 tie and 2-1x6 studs.

5. *Sheeting.* Cover all outside walls as well as roof with 1"

inch surfaced sheeting well nailed to every bearing. On inside ceil up with No. 2 1x6 M. & D., all except coal room which is to be sheeted up with same material used for outside sheeting.

6. *Window Frames.* All sash windows will be 1 $\frac{3}{8}$  inch thick and have frames with pockets for weights and good axle pulleys. There will be 2-inch sides, blind stops, pulley stiles, and outside casing. All windows except coal room to contain two lights 24x30, windows in coal room to be hung with 3x3 butts and to have hook fasteners.

7. *Roof.* Covered with 26 guage metal roof.

8. *Paper.* Under all roofing and siding cover sheeting with red rosin sized building paper, well lapped and brought up carefully to cornice and frames.

9. *Outside Finish.* All outside finish will be of No. 2 pine free from pitch and loose knots. Corner boards and base will be of 1-inch stuff. Cornice to consist of 1x8 frieze, 1x12 plancia, 1x4 facia, 3 $\frac{1}{2}$  inch crown moulding and 2-inch bed mould.

All other outside finish will be No. 2, 6-inch rustic.

10. *Ventilators.* To consist of two good weather proof galvanized iron ventilators of at least 150 inch capacity each.

11. *Flooring.* 1x4 vertical grain Oregon fir over all except engine and boiler room and coal room.

Coal room to have no floor but leveled up with earth to the level of engine and boiler room floor.

There will be a gutter for drainage running the entire length of the make room floor, which will also drain the engine and boiler rooms as well as refrigerator room.

12. *Inside Finish.* All openings to be cased up with 1x4 No. 2 pine for paint.

13. *Doors.* All interior doors to be four panel 1 $\frac{3}{8}$  inch No. 2 doors for paint with 2 feet 6 inch by 6 feet 8 inch openings. Double doors to be built up with 1 $\frac{1}{4}$  inch stiles and rails, halved intersections and covered on opposite side with No. 2 1x4 M. & D. and to have 5 feet by 7 feet opening. Double door in milk receiving room to have 2 feet 6 inch by 3 feet opening.

14. *Sash.* All sash will be of pine 1 $\frac{3}{8}$  inch thick and glazed with two 24 inch by 30 inch lights as shown, with good quality

window glass. All double windows to be hung with cast iron weights to balance with braided sash cord.

15. *Stairs inside* to raise 3 feet to milk receiving room with  $7\frac{1}{4}$  inch raise and 9 inch breadth steps.

16. *Hardware.* All outside double doors to have head and foot bolts and good thumb latch and No. 42 Yale cylinder night latch.

Interior doors to have mortised knob locks with long escutcheon and jet knobs.

All sliding windows to have 2 sash lifts and Ives sash lock, Berlin bronze finish.

17. *Painting.* Roof to have two coats of mineral paint. All outside woodwork to have two good coats of strictly pure lead and oil paint, colors to suit.

Inside, with exception of coal room, to have two good coats of paint, colors to be selected.

#### COST OF BUILDING.

The cost of this building will vary slightly, according to the local cost of material in the particular locality.

We submitted these plans to a contractor who figured lumber from the following prices:

2x4, 2x6, 2x10.....	\$17.50 per 1000.
Sheeting.....	17.50 per 1000.
1x4.....	22.00 per 1000.
1x6.....	25.00 per 1000.
No. 2 ship lap or rustic.....	26.00 per 1000.
Oregon fir.....	35.00 per 1000.
Window frames.....	\$1.25 to \$2.50 each.
Doors 2 ft. 6 in. x 6 ft. 8 in.....	\$3.50.
2 ft. 8 in. x 6 ft. 8 in.....	\$4.00.

The contractor's figure on this building was \$2000 to \$2200 finished according to foregoing plans and specifications, \$2000 being a safe estimate in most localities.

## MACHINERY FOR CREAMERY.

A great many firms in outlining the machinery for a plant only give a list of the larger and more important parts of the machinery and never mention the large number of smaller things that are absolutely necessary in the creamery. Take for example such things as salt, oil for engine, cylinder and cream separator, butter color, extra brushes, parchment wrapping paper, shipping boxes or tubs, radiators, pails, etc

The following is a complete list of everything in the line of machinery, equipment and supplies needed to begin running a creamery.

### LIST OF MACHINERY.

1 20-H. P. horizontal boiler, complete with all fixtures including door, grate bars, bearing bars, pop valve, steam guage and syphon, water column with glass water gauge, 3 guage cocks, feed, check and blow-off valves, injector fitted to boiler, whistle, smoke stack and saddle, guy wires, flue cleaner, poker, coal scoop, etc.

400 fire brick.

1 barrel fire clay.

1 15-H. P. horizontal engine with brass oiler and Detroit lubricator.

1 boiler feed pump with lubricator.

1 4x6 steam well pump.

1 Separator of 3,000 pound capacity per hour.

1 Churn, working capacity 600 pounds butter.

1 200-gallon galvanized skim milk vat.

1 300-gallon galvanized butter milk vat.

1 300-gallon galvanized water tank.

1 400-gallon milk receiving vat.

1 Twin cream vat (300 gallon, ice box on end).

1 24-bottle Ideal tester.

1 600-pound five beam scale.

1 60-gallon weigh can.

- 1 Conductor head and 5-ft. trough.
- 1 Milk strainer.
- 1 Ideal wash sink, No. 2.
- 2 No. 1 rotary milk pumps.
- 1 Whole milk heater.
- 1 Pasteurizer for skim milk.
- 1 Ideal skim milk weigher.
- 1 Noiseless water heater.
- 1 14 inch iron head mop with one half dozen extra rubbers.
- 1 250-page milk ledger.
- 4 dozen weekly milk sheets.
- 1 Newton computer.
- 1 dozen Babcock test bottle brushes.
- 1 Cream acid tester complete.
- $\frac{1}{2}$  dozen composite test jar brushes.
- 50 T. T. pint sample test jars.
- 1 18 inch butter tryer.
- 1 8-ounce graduate for color.
- $\frac{1}{2}$  dozen common floating thermometers.
- 1 Butter packer.
- 1 Dairy or New York style ladle.
- 1 Factory ladle.
- 1 Butter salting scale.
- 4 16x1  $1\frac{1}{16}$  adjustable drop hangers.
- 2 1  $1\frac{1}{16}$  shaft collars.
- 28 feet  $1\frac{1}{16}$  inch shafting.
- 20 feet  $\frac{3}{4}$  inch 4 ply steam hose.
- 30 feet  $\frac{3}{4}$  inch 3 ply conducting hose.
- 1 Belt awl.
- 50 feet cut rawhide lacing.
- 5 pounds Italian hemp packing.
- 1 pound each piston and cylinder packing.
- Necessary connections in black piping for boiler, engine, pumps, wash sink, pasteurizer, vats, etc. Necessary check globe and angle valves (Jenkins) for above.
- $\frac{1}{3}$  Dozen extra seats for all valves used.
- Necessary ells, tees, unions, nipples, reducers, couplings,

plugs, etc., for above.

- 1 Main drive wood split pulley.
- 2 Wood split pulleys for rotary pumps.
- 1 Wood split pulley for churn.
- 1 Separator wood split pulley.
- 1 Pulley (wood split) for starter can.  
(Size of pulley will depend upon speed of engine).
- 2 14-quart pails.
- 1 Starter can.
- $\frac{1}{2}$  Dozen gallon butter color.
- $\frac{1}{4}$  Dozen scrub brushes.
- $\frac{1}{2}$  Dozen ox fibre brushes.
- $\frac{1}{8}$  Dozen A. B. C. brushes.
- 3 Gallons sulphuric acid (commercial).
- 2 Boxes preservative tablets.
- 1 S. H. dipper (gallon).
- 1 S. H. dipper (1-2 gallon).
- 1 Barrel butter salt.
- 1 Butter maker's set of tools (including saw, hammer, brace, and set bits, wrenches, dies, etc.)
- $\frac{1}{2}$  dozen extra separator ropes.
- 1 Elbow strainer for churn.
- 1 Butter printer.
- 3000 Parchment wrappers.
- 100 K. D. 54-pound shipping boxes.
- 1 Keg floor powder.
- 1 Spring belt punch.
- 10 pounds waste.
- 5 Gallons engine oil.
- 5 Gallons cylinder oil.
- 5 Gallons separator oil.
- 1 Refrigerator, 8x12 feet.
- 2 Radiators for make room.

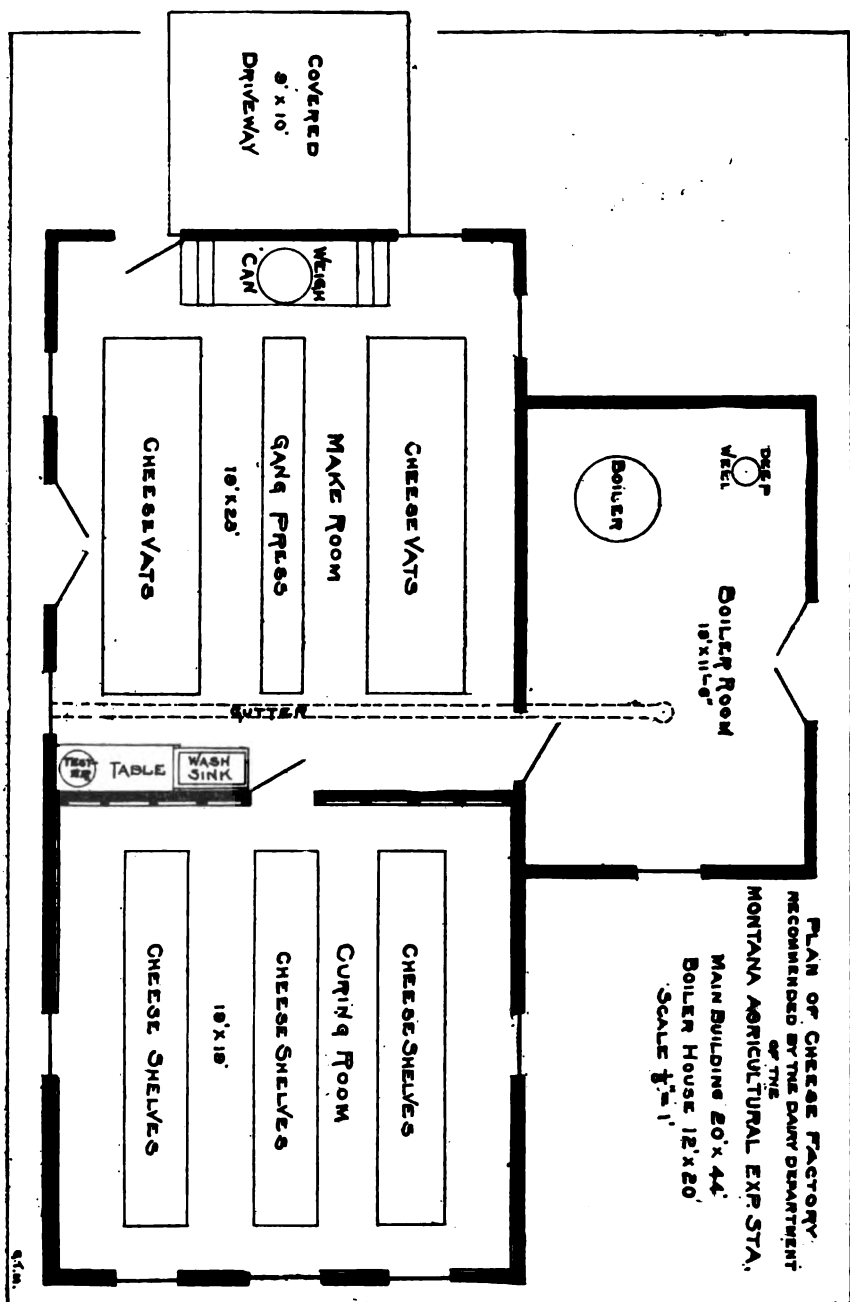
Now in a number of cases we have not specified just exactly the particular make to get, for in such cases there are a number of standard varieties that are equally good. Should anyone desire particular advice on any particular make of machinery, we will be

pleased to help if they write us at the Dairy Department of the Agricultural Experiment Station.

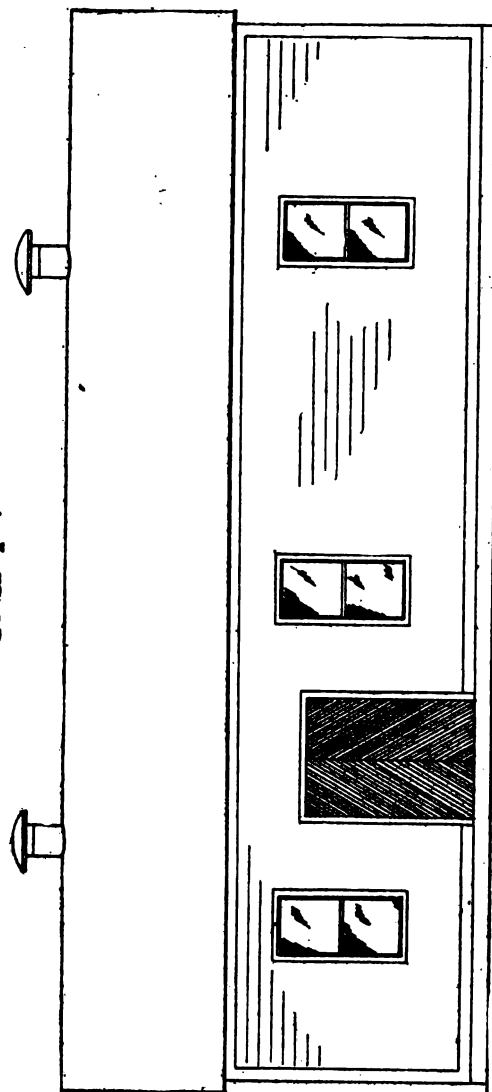
Considerable money can be saved by the farmers getting together and deciding how many milk cans they will need, and also the sizes they want, and ordering them to come in the car of machinery. By this means they can be obtained practically freight free as the freight on the car of machinery will be a fixed rate anyway.

#### COST OF MACHINERY.

The machinery listed above can be laid down anywhere in Montana for \$2300.00, and it will cost in the neighborhood of \$200 for local drayage, installing the machinery and doing the necessary piping. So that \$2500.00 is ample to pay for a complete list of machinery, including the freight and the cost of installing it. Thus the plant complete will cost for building \$2000.00, and for machinery \$2500.00. Making the total cost of a 500 to 1000 cow capacity creamery \$4500.00.

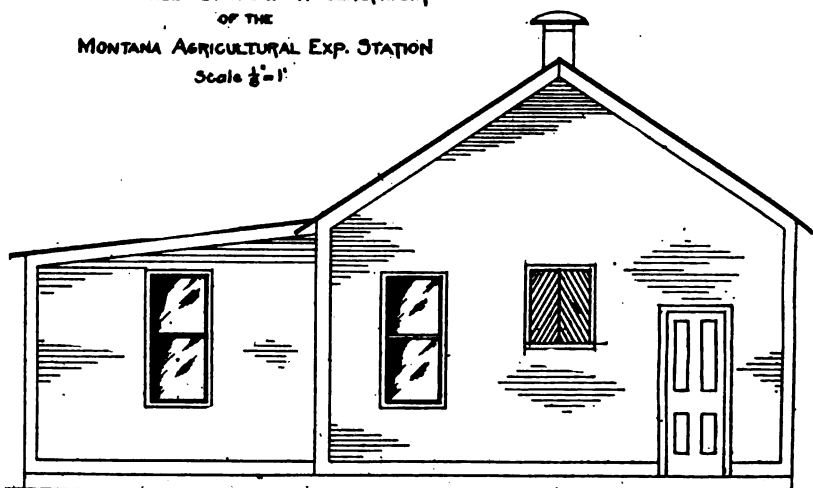


PLANS FOR CHEESE FACTORY  
 OF THE  
 MONTANA AGRICULTURAL EXPERIMENT STATION  
 SCALE  $\frac{1}{4}'' = 1'$

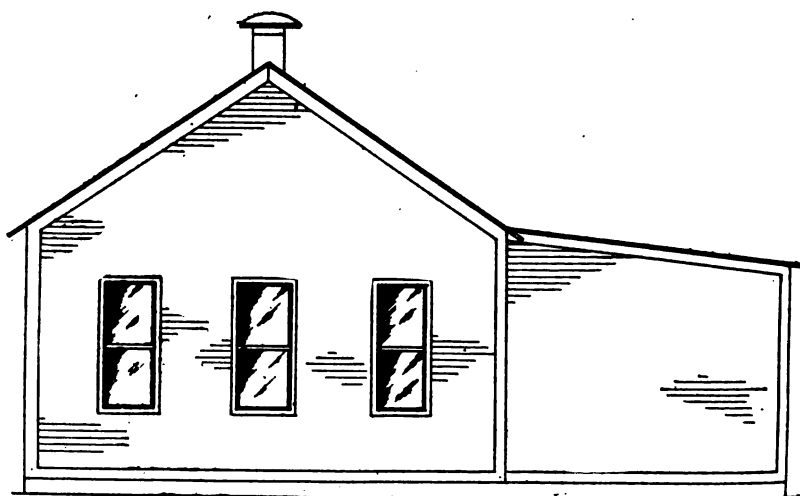


FRONT ELEVATION

PLANS FOR CHEESE FACTORY  
RECOMMENDED BY THE DAIRY DEPARTMENT  
OF THE  
MONTANA AGRICULTURAL EXP. STATION  
Scale  $\frac{1}{8}" = 1'$



RECEIVING-END ELEVATION



END ELEVATION

### CHEESE FACTORY.

The same may be said of the requirements and location of a cheese factory as was said of a creamery, with the exception that it does not require as many cows for the successful operation of a cheese factory as for a creamery. A very successful cheese factory can be run with 150 to 200 cows, and such a plant will pay just as well, and possibly a little better, than a creamery with 300 cows at the present prices of cheese. With the same number of cows and at the prevailing prices there is more money in making cheese, by 20 cents per hundred of milk, than by making butter, but the patron has to wait a little longer for his money as cheese has to lie on the shelves from four to six weeks before it is ready for market.

Herewith are given plans of an up-to-date cheese factory.

### SPECIFICATIONS.

The main building shall be 20 ft. 44ft., 10 ft. ceiling and  $\frac{1}{8}$  pitch roof with a boiler room on the side 12 ft. x 20 ft.

1. *Trenches.* Same as trenches under specifications for creamery, page 75.

2. *Stone Work.* Same as under creamery specifications, page 75.

3. *Cement Work.* Only the boiler room will have concrete floor. Cement work to be made and laid as under creamery specifications, page 75.

4. *Carpenter Work.* Same as under creamery specifications, page 75.

5. *Sheeting.* Cover all outside walls as well as roof with 1 inch surfaced sheeting well nailed to every bearing, also walls and ceiling of curing room with same material. On inside, except curing room, ceil up with No. 2 1x6 M. & D.

6. *Window Frames.* All windows to contain two lights 24 inch x 30 inch. All the rest same as under "Window Frames," creamery specifications, page 76.

7. *Roof* of main building and boiler room to be covered with 26

guage metal roofing.

8. *Paper.* Under all roofing and siding cover all sheeting with red rosin sized building paper well lapped and brought up carefully to cornice and frames. In addition the inside walls and ceiling of curing room to be covered on top of 1 inch sheeting with same paper nailed on with 1 inch x 2 inch strips, 16 inch centers. On top of these strips put 2 perpendicular layers of same kind of building paper and ceil up with 1 inch x 6 inch M. & D., thus making two dead air spaces.

9. *Outside Finish*, same as creamery specifications, page 76.

10. *Ventilators*, same as creamery specifications, page 76.

11. *Flooring*, 1x4 vertical grain Oregon fir over all except boiler room. There will be a gutter running across the make room to which the floor from both sides will slope.

12. *Inside Finish.* Same as creamery specifications, page 76.

*Doors.* All doors same as creamery specifications, page 76.

13. *Sash.* Same as creamery specifications, page 76.

14. *Platforms.* There will be one platform in the make room to hold the weigh scales and weigh can to carry 800 pounds. Platform to be 4 ft. x 8 ft and 3 ft. above the floor. Steps rising to it to have 7¼ inch raise and 9 inch tread.

Where necessary there will be a platform outside of boiler room to hold cans while the patrons are loading up the whey. Platform to be the same size as the one inside.

#### MACHINERY FOR CHEESE FACTORY.

1 8-H. P. upright boiler complete with fixtures as follows: stack, grate bars, pop valve, steam guage and syphon, water column, with glass water guage, 3 guage cocks, feed, check, and blow-off valves, injector fitted to boiler, whistle, guy wires, flue cleaner, poker, coal scoops, etc.

1 Steam well pump.

Necessary iron pipe for all piping inside factory.

Necessary ells, tees, unions, nipples, reducers, couplings, plugs, etc., for above.

Necessary valves for above fittings (Jenkins).

- 1 600-pound 5 beam Fairbank scales.
- 1 240-pound S. B. scale (Family).
- 1 80-gallon weigh can.
- 1 Conductor head.
- 6 Foot conductor trough.
- 1 500-gallon cheese vat (2 inch gate).
- 2 Curd racks.
- 1 Combination Cheddar and Y. A. cheese press.
- 1 Harris curd mill.
- 12 14½ inch seamless hoops.
- 6 Y. A. seamless hoops.
- 1 24-bottle Facile tester.
- 1 15-barrel steel tank.
- 1 Curd pail.
- 1 14-quart pail.
- ½ dozen floor scrub brushes.
- 3 Jorsey brushes.
- 500 yards 14½ cheese bandage.
- 500 yards Y. A. cheese bandage.
- 4 Gallons Hansen rennet.
- 1 Gallon cheese color.
- 1 Gallon acid.
- 1 Box cor. sub. tablets.
- 1 Allens pay roll.
- 1 S. and S. record.
- 1 Dozen rec. sheets.
- 2 Dozen pint T. T. bottles.
- 1 17-barrel steel tank.
- 1 8x20 Hor. curd knife.
- 1 14x20 Perp. curd knife.
- 1 L. H. Dipper (½ gallon).
- 1 S. H. Dipper (1 gallon).
- 1 Whey strainer for cheese vat.
- 1 Curd scoop.
- 1 16-ounce graduate.
- 1 Stirring knife.
- 1 Gram measure.

- 1 Cheese knife for hoop.
- 1 Dating stencil, paste and brush.
- 1 Floor mop 14 inch with  $\frac{1}{2}$  dozen extra rubbers.
- 6 Floating thermometers.
- 1 Barrel cheese salt.
- 1 4x8 Moore pump.
- 1 Wash sink, galvanized.
- 1 Noiseless heater.
- 1 Dozen brushes.
- 1 M. 13 1-2 cloth circles.
- 1 M. 6 1-2 cloth circles.

#### TOTAL COST OF CHEESE FACTORY.

The same prices have been figured on lumber for the cheese factory as for the creamery. Such a building constructed as per plans and specifications here given can be built for \$1500.

A complete outfit of the very best cheese factory machinery, for such a plant, can be laid down in Montana, and placed in shape in the factory ready to run for \$800. This price includes actual cost of machinery, freight from Minneapolis or St. Paul to Montana, and the cost of installing said machinery in factory. Thus the factory complete can be built for \$2300. This price may vary \$100 one way or the other according to the local price of material.

These plans and specifications are given with the hope that they may be of use to those who are thinking of building, and if any one is desirous of using these plans, blue prints may be had by applying to the Dairy Department of the Experiment Station, Bozeman, Montana.

As far as possible, any other help towards the building and equipping of either plant will be cheerfully given.







MONTANA AGRICULTURAL COLLEGE  
EXPERIMENT STATION

F. B. LINFIELD, DIRECTOR



BULLETIN NO. 54

# THE ALKALI SOILS OF MONTANA

BY  
F. W. TRAPHAGEN

BOZEMAN, MONTANA  
OCTOBER, 1904

# MONTANA AGRICULTURAL COLLEGE EXPERIMENT STATION

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# THE ALKALI SOILS OF MONTANA.

## SECOND BULLETIN.

In presenting the results of Alkali soil examination of the past few years, it has been deemed advisable to repeat some of the observations and conclusions of Bulletin No. 18, the edition of which is completely exhausted. To this end the following resume of work done in Montana and elsewhere is offered as an introduction to the detailed discussion of the soils of the particular localities investigated.

### ORIGIN OF ALKALI.

By alkali soils is meant such soils as contain an excess of soluble mineral salts. Two kinds of such soils are known and are called respectively "Black Alkali" and "White Alkali." The so-called alkali soils are found only in arid or semi-arid districts. In the formation of soils, rocks are disintegrated by the various weathering agents, the most easily decomposed constituents of the rocks being resolved into a soluble component and an insoluble residue. The particular constituent attacked is usually in sufficient quantity to act as a cement to the other constituent minerals of the rock, thus holding them together. By the solution of a considerable portion of this cementing material the remainder is left in such a slightly coherent condition that it is no longer capable of holding the rock together; it thus falls into a loose pulverulent mass the particles of which are of a greater or less size depending upon the size of the original particles. This mass constitutes the original soil which, after being acted upon by the lower forms of vegetable life, ultimately becomes capable of supporting the ordinary crops of the farm.

Now the question of whether or not we shall have an alkali soil after the rock has become disintegrated depends upon the subsequent history of the soluble portion of the original rock. If the climate is humid we have an excess of water to carry away, in solution, soluble salts as fast as formed and ultimately to deposit these salts in the ocean. If, on the other hand, there is scant rainfall, as in arid climates, and the run-off, i. e., the water falling on the surface and passing off without being absorbed by the

soil, is so slight that but a small portion of the soluble salts is removed, these will accumulate to an alarming extent where conditions are favorable to this action.

Let us take a concrete example in illustration of this process. One of the most common rocks is granite which is composed of quartz, mica and feldspar the last being regarded as the cementing material. The quartz is composed of silica which is one of the most insoluble substances in nature and is but little influenced by the disintegrating effects of the various agents active in soil formation; mica contains nearly fifty per cent. of silica, the remainder of its weight being chiefly of alumina which is not readily soluble together with small amounts of potash and oxide of iron; the third constituent, feldspar, is composed of silica, alumina and potash and, while it contains more silica than mica, nearly two-thirds of its weight being silica it is much more easily decomposed than the mica and it is because of the partial solution of this mineral that the rock is weakened and falls to pieces. As thus formed the soil consists of particles of quartz sand and flakes of mica distributed through a mass of loose clay resulting from the decomposition of the feldspar, the whole mixture in turn being permeated by a solution of potassium carbonate and potassium silicate. Now, whether these salts or similar ones formed by the various changes constantly taking place remain in the soil or are carried away depends, as already stated, upon the climate.

**Black Alkali:** This is of alkaline reaction, the alkalinity being due to the presence of sodium carbonate, "sal soda," in greater or less quantity, and is characterized by a blackness of the soil in which it occurs. This blackness of the soil is produced by the deposit of organic matter, dissolved from organic substances by the alkaline solution of the soil, and left behind after evaporation of the water. This condition is particularly noticeable around the edges of evaporating pools, and upon the complete evaporation of such solutions the former bottom is found covered with a slimy black deposit of finely divided material.

Alkali soil of this sort is extremely uncommon in Montana. On the other hand, a very much smaller quantity of the black alkali is injurious to crops than of the white variety. The most common

remedy for black alkali is its conversion into the less harmful white alkali. The researches of Dr. E. W. Hilgard and his associates in California have shown that much above one-tenth per cent. of black alkali in the surface foot of soil is prohibitive to plant growth.

The action of black alkali is a corrosive one, the vegetable matter being dissolved wherever the comparatively strong alkaline solutions come into contact with it. The plants, especially at the point where the stem emerges from the earth, are often affected to such an extent as to be completely eaten through, and as a consequence a crop may be completely prostrated by the "rise of alkali."

By the application of a top dressing of gypsum, (sulphate of calcium,) a chemical change is brought about resulting in the production of two new substances, the black alkali, (sodium carbonate,) being changed into the less harmful white alkali, (sodium sulphate,) and the gypsum being converted into the equally harmless calcium carbonate or limestone.

**White Alkali:** This is entirely non-corrosive in its action on vegetable matter, and as already mentioned, is not nearly so harmful in effect as the same amount of black alkali would be. White alkali is composed principally of soluble sulphates, chiefly of sodium and magnesium the former making up the greater part of the mixture; more or less calcium sulphate is also present and these three salts comprise the bulk of nearly all white alkalis, the remainder of the salts being composed of very small quantities of the usual soil-water constituents. Whether the alkali is "black" or "white," depends not only upon the question of its origin but also upon the subsequent reactions of the constituent salts. Thus while it is very unlikely that white alkali would be changed into black yet it very frequently happens that, either by accident or design, the black alkali is changed into the less harmful white through the reaction already discussed.

### RISE OF ALKALI.

So long as the salts are distributed through the soil uniformly and do not reach too high a percentage in the surface foot no harm results to vegetation; but, with the advent of irrigation, many sections previously giving no indications of alkali begin to show its presence.

The processes which bring these soluble salts to the surface

are exceedingly simple and easily understood. As is well known, water is Nature's great solvent, and in its course downward into the soil after a rainfall or after the much heavier irrigation, it takes up all soluble matters with which it comes into contact; it thus soon comes to be heavily charged with various salts. These salts, being very soluble, can only be separated from the water in either of two ways; in one the salts would be changed into insoluble compounds when separation could be easily effected. This conversion into insoluble salts is very unusual and extremely unlikely to occur in nature, though it is not an uncommon thing in the chemical laboratory. This leaves the separation of the water and salts to be brought about, if at all, by the other method. This, unfortunately for agriculture in irrigated regions, is only too easily effected. This method is the evaporation of the water from the salt, the latter being left behind on or near the surface of the soil.

In its downward course through the soil water will take up soluble matters until it becomes saturated with them so that it may hold any quantity of salts up to its point of saturation. When the application of water through irrigation temporarily ceases, the direction of the water flow is reversed, and instead of passing from the soil surface downward, it now comes from below to the surface bringing with it its full complement of dissolved materials.

This upward movement is due to the capillary action of the soil and it is a fact that some soils have a capillary power sufficient to enable them to lift water to the surface from a depth of eight feet or more. As this salt-charged water reaches the surface it comes under the influence of the sun's rays and is more or less rapidly evaporated. In this process, however, only the water passes off, the salts remaining behind in exactly the place where they can do the most damage to vegetation. A fresh application of water may be accompanied by a partial carrying down of some of the soluble surface salts but, on the return of this water to the surface through the processes enumerated, it carries with it, not only what it took down, but also an additional quantity of deleterious matter which is thus brought within the danger limits. With the continuation of this process sooner or later a condition is reached prohibitive to vegetable growth.

Another cause of the rise of alkali, more serious in its effects because accompanied by another objectionable feature, is the rise

of the ground water due to excessive irrigation. Charts of underground conditions designed primarily to show the depth to ground water, or permanent water level, show that with the progress of irrigation this water-table—as it is sometimes called—approaches nearer and nearer to the surface until in many cases it becomes actually coincident with the surface. This not only brings about a concentration of mineral salts at the surface, but, because of the ill effect of excess of water upon certain crops, notably alfalfa, would bring about an extermination of the crop even if unaccompanied by an excess of alkali. It is a well-known fact that alfalfa cannot exist with its roots surrounded by a soil saturated with water, and often in alkali districts I have been compelled to attribute the killing out of alfalfa to excess of water rather than to excess of alkali.

This condition of excess of alkali accompanying a rise of the ground water can be brought about by over-irrigation at the point where the trouble develops or may result from over-irrigation on the part of one's neighbors occupying higher land or by means of leaking ditches at higher points than the affected lands. The two latter causes bring about more serious conditions than do exist when both cause and effect are purely local for the water not only comes to the surface under a greater or less hydrostatic pressure but passing through a much greater area of alkali-containing soil has an opportunity of taking up correspondingly greater quantities of alkali salts ultimately to deposit on the surface.

### REMEDIES.

In the light of what has already been said, the discussion of the remedy for the "rise of alkali" can now be intelligently considered. It is evident that these remedies may be considered under three heads, namely: Prevention, Amelioration, and Eradication.

**Prevention:** This resolves itself into two parts: first, avoiding to as great an extent as possible, the solution of objectionable matters and, second, reducing surface evaporation to a minimum.

The first of these results can be attained only by limiting the use of water to the actual needs of the crop and by avoiding a too deep and too great saturation of the soil. This involves also a control of seepage from higher points to prevent rise of the

ground water through leakage of ditches or over-irrigation on the part of neighbors located on higher ground. It is plainly apparent that the trouble we are aiming to avoid, being due to the carrying up of salts from below, can also be prevented if we can carry off the dissolved salts below. This can be done by under-drainage which will be more fully discussed under the third section.

**Amelioration:** When the salts reach such a percentage in the upper portion of the soil that their ill-effects begin to be apparent, it becomes necessary to reduce their quantity below the danger limit or to plant some crop of greater alkali-resistant power. Such crops, if they, like alfalfa or sugar-beets, either through their foliage or through their culture, assist in reducing the rate of evaporation, are great aids. In addition to this I have found that the alfalfa from alkali districts has a much greater percentage of ash, principally alkali salts, than that from non-alkali sections, hence the alkali would be constantly removed with the crop ultimately leaving the soil in a condition fit to support any crop. Sugar beets also have been found to take enormous quantities of alkali salts from the soil but, unfortunately, such beets are not suitable for the manufacture of sugar.

Ploughing in of manure, straw or similar material, especially as soon after an irrigation as it is possible to work the ground, will be found useful for two reasons: first, the admixture of this material with the soil proportionately reduces the percentage of alkali: and, second, it reduces the rate of evaporation, especially if more of this material is applied loosely over the surface.

It must be understood that the success of this treatment is due not to any chemical reaction but solely to the reduction of the relative amount of alkali on the surface of the soil, and further to the reduced rate of evaporation brought about by the changed texture of the surface soil.

The reason for applying this mulch as soon as possible after the use of water is that the surface alkali is temporarily carried down into the soil as previously explained and much of it may thus under proper treatment be kept out of the danger zone.

By judicious surface flooding of the land the amount of alkali in the surface portions may be temporarily reduced. This method requires great care or the conditions will be made worse instead of better. Two conditions for the successful application of this

process are imperative, namely: plenty of water and a suitable slope to make possible the immediate removal of the salt-saturated water. This scheme of treatment may be successfully followed to bring about the removal of the greater part of the surface crust of alkali so commonly seen in badly affected alkali districts, but it must only be considered as a temporary expedient and not as a final remedy. The same thing may be said of the other methods of treatment so far discussed.

**Eradication:** This can only be brought about in one way—by under-drainage. When there is an efficient natural under-drainage there is no alkali. This of itself should give us confidence in the efficacy of the method under discussion.

Artificial under-drainage is, of course, very expensive and it has been a question whether, with the comparatively cheap lands of the west, under-drainage was economically advisable; whether, in other words, it was wise to put as much, or more, than the rated acre-value of the land, into a system of under-ground tiling for the purpose of drainage.

It seems to me that the question is rather:—Have we put a proper valuation on our farm lands? Are lands which produce five tons or more of alfalfa per acre worth only the low price current? In eastern farming districts the yield per acre rarely nets as much as the irrigated lands of Montana, for instance of the Yellowstone valley. Yet when the necessity for under-drainage is apparent in the east a system is at once installed. If the basis for the valuation of land is its annual yield per acre, is the land properly appraised? If more highly appraised land in the east yielding no larger crops can be economically under-drained why can ours not be treated the same way?

Under-drainage, let it be well understood, is not a provisional remedy but a final one. Land so treated soon comes up to its maximum efficiency and can be so maintained with proper handling. A year or two before land becomes barren, through rise of the alkali, almost phenomenal crops are raised. This is because the alkali is not a poison but a plant food when present in properly limited quantities: it is even a necessity; it is the life of the plant. It is only when it is in excess that trouble ensues. Even the most necessary and most important plant food would prove deleterious and even prevent plant growth if present in too great a quantity.

Under-drainage makes possible a control of the quantity of salts in the soil. Over-irrigation in a properly drained field will now produce no ill results except that attendant upon a perversion of the water from a possibly more useful channel. On the other hand, excessive use of water is followed by a corresponding carrying off of dissolved salts downward through the avenues provided for the escape of this water, so that, instead of the excess of water bringing to the surface great quantities of mineral salts to kill plant life, it actually carries away these salts soon leaving the soil in ideal condition. Here too, however, there is danger of carrying this process too far for an excess of mineral salts is distinctly harmful. On the other hand, small quantities are absolutely necessary and extreme care should be exercised to prevent loss of these very important plant foods which are available only when in a soluble form in which form also they are most likely to be carried off.

In irrigation, then, the farmer has a two-edged sword which must be wielded with the greatest care; properly handled, the best results are obtained: improperly handled, ruin is almost sure to follow.

Another advantage possessed by proper under-drainage is the protection it affords its owner against damage through seepage from higher lands or ditches, for with this system in use the ground water is limited in its rise by the drain tiles.

*Under-drainage is the remedy for the "rise of alkali" and should be adopted wherever possible.*

As a concrete example of what can be done by use of the system herein advocated, the following resumé of actual results accomplished by Messrs. Means and Heilman of the United States Department of Agriculture is offered in evidence:

**"Reclamation of Alkali Land at Fresno, California."**

"At the time of settlement of the country south of Fresno there was a little indication of the presence of alkali in the soil and no one then suspected that serious damage would result from irrigation. When, after a few years, alkali commenced to show in the vineyards and orchards the attention of thoughtful men was directed toward remedying the evil but up to the time of undertaking the experiment herein reported nothing effective had been accomplished.

"In 1900 a party from the Bureau of Soils spent a season in

studying the soil conditions around Fresno, and in a paper embodied in the report on field operations of the Division of Soils for 1900 recommended drainage with frequent cultivation and copious irrigation during reclamation, as the solution of the alkali problem.

"Notwithstanding the recommendations in this report and the repeated statements in subsequent reports on alkaline areas in different parts of the country that drainage is a practicable and the only safe and sure means of permanently reclaiming alkali lands, no steps had been taken by persons most deeply interested to check or remove the evil. The Bureau of Soils, after careful consideration, decided that the most convincing way of bringing the truth of its recommendations and the value of drainage in reclamation work before the people was to demonstrate it by actual reclamation of some of the alkali land. For this purpose the Bureau selected a 20 acre tract of land belonging to S. M. Toft and N. H. Hansen situated on Fig and Central avenues about  $2\frac{1}{2}$  miles south of Fresno and entered into cooperation with these gentlemen to demonstrate to the people of the irrigated region that alkali lands can be easily and economically reclaimed.

"The history of this land, as given by the owners, is as follows: The northern part of the tract was settled upon by Mr. Toft in 1876 and at that time showed no signs of alkali. The southern part of the tract was first settled upon in 1862 by Mr. Hansen and at that time was partially alkaline. It has never produced good crops. In 1890 alkali commenced to show on the northern part and in 1898 and 1899 it was practically abandoned.

"The tract lies in a level district where it is impossible to obtain a gravity outlet for the drainage water except by digging a drain 2 miles long, so in order to raise the drainage water to the surface of the ground, a chain pump operated by a water wheel was installed on Central Canal where it crosses Fig avenue. A drainage system of this kind is admittedly not so desirable as one in which a gravity outlet can be maintained.

"Three-inch, 4-inch and 6-inch tile were laid over the tract at an average depth of a little over 3 feet and 150 feet apart. The original intention was to use nothing smaller than 4-inch tile but the makers were unable to supply enough of this size so the deficiency was made up by using 3-inch tile. It was found impossible to lay the tile during the summer season, owing to the nearness

of the water table to the surface and the resulting condition of the subsoil which was too soft to permit the digging of a deep ditch. The work of ditching was commenced in December, 1902, and was completed in February, 1903. The cost of ditching, tiling, and all incidentals except the cost of pump and water wheel amounted to \$16.50 per acre. The contract for the tile delivered in Fresno was for 3-inch tile, \$24 per thousand, for 4-inch tile, \$32 per thousand, and for 6-inch tile, \$72 per thousand.

"At the time of the installation of the drains 18 acres of the land contained too much alkali to produce a crop. Scattered over a part of the tract were small patches of alfalfa and an occasional fruit tree—remnants of former cultivation. About the 1st of March 1903, irrigation was commenced. The land was divided into 30 checks the size of each check depending upon the slope of the land. The largest checks, those on the level land, are about 2 acres in extent, while on the steeper slopes they are less than half an acre. The object was to divide the land in such a way that it could all be kept under water to a depth of 4 inches, and the reclamation was to be accomplished by maintaining the water at this depth until enough alkali had been washed out of the soil through the drains to enable a crop to be grown.

"During the progress of flooding many difficulties were met, among them that of keeping the tiles from partially filling with sand and silt. Precaution was taken in laying the tile to put them in so that the joints would be close. Hay was thrown over the tile in the ditch before covering with earth and a ridge of earth was thrown up to prevent the water from standing directly over the drains. In spite of these precautions the soil, which is very light, was so easily moved by water that it seemed to enter the joints almost as readily as the water. This resulted in some of the drains becoming clogged and it was necessary to relay a portion of the tile. After the land had been once thoroughly soaked and had settled, no difficulty was experienced from filling of the drains and it is to be hoped that there will be no further trouble from this source. Most of the trouble was with the 3-inch tile which is admittedly too small for use in soils of the light and silty character of the Toft-Hansen field. It is thought that there will be more or less silting up of the tiles whenever they are used in the sandy and white ash soils of the Fresno district and it was recommended

that every possible precaution be taken in putting them in. Much of the trouble may be obviated by using no tile smaller than 4-inches, or preferably 6 inches in diameter, and by giving the laterals such fall that the velocity of the water will be great enough to wash out the sand as rapidly as it enters the joints. The tiles on the Toft-Hansen tract have a fall of 1 in 1,000 and the velocity of the water flowing through them is not sufficient to remove the sand. With a fall of 1 in 500 the velocity is great enough to remove practically all of the soil as fast as it enters.

"To prevent entirely the clogging of the tile with sand and to insure the removal of roots should any chance to enter, it is thought advisable to place in all tiles a quarter inch galvanized strand-wire rope. Then two or three times a year, or oftener if necessary, a wire brush should be dragged through the tile in order to cut out all roots and stir up the sand and silt. Wire rope of this kind can be bought for about 1 cent a foot. Six-inch and 8-inch drains have been in operation for twelve years in the Sunnyside vineyard and have been kept in perfect condition in this way. From the experience gained the Bureau can unhesitatingly recommend tile for drainage purposes provided proper precautions are taken in its installation.

"On July 15, 1903, after four and a half months of irrigation, an examination was made of the tract to determine what percentage of the land was sufficiently sweetened to grow a crop. This examination indicated that all of the land, with the exception of small spots amounting in the aggregate to less than 2 acres, was then ready for a crop. Most of it was sufficiently freed from alkali to warrant the sowing of alfalfa but as midsummer is not the best time of the year for seeding that crop, sorghum and Egyptian clover were put in instead. These crops will mature by fall if the supply of irrigation water does not fail, and in the winter the land will be seeded to alfalfa. The small spots which are not yet ready for alfalfa are rapidly approaching that condition and will be ready for a crop during the coming winter. Thus it will be seen that practically all the land in this 20-acre tract has been returned to a state of profitable cultivation in a period of four and a half months after irrigation was commenced, and the statement seems justified that any alkali land in the Fresno district can be brought into profitable cultivation in less than one year's time the two requisites for this

being under-drainage and a copious supply of water for irrigation. While the Bureau considers the land of the Toft-Hansen field practically reclaimed at the present time the demonstration will be continued until a satisfactory stand of alfalfa is secured."

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### EXPERIMENTS TO DETERMINE THE EFFECTS OF ALKALI.

An inspection of the plates will show plainer than words the results of these experiments. In explanation it may be said that the soil used was the best soil of the Montana Experiment Station farm. Where the word "blank" is used, it indicates that the soil alone was present, while in each of the other pots, the soil had added to it an amount of alkali, in percentage of its own weight, as designated.

The presence of magnesium sulphate—epsom salt—in quantity up to one per cent has apparently no ill effect upon the growth of alfalfa.

The limiting quantity of sodium sulphate—Glaubers' salt—for alfalfa seems to be about seven-tenths of one per cent.

With a mixture of two-thirds sodium sulphate and one-third magnesium sulphate, which in these experiments is termed "mixture", and which represents very closely the composition of Montana alkali, the limiting quantity appears to be about the same as with sodium sulphate alone.

It should be said that these experiments were conducted with great care, the purpose being to eliminate every adverse condition except that imposed by the presence of the "alkali". Especially was it provided that a sufficient quantity of water should always be present..

In this connection it may be stated that the presence of alkali was observed, in another series of experiments, to very materially increase the draught-resistant powers of the plants under investigation.

Plates IV and V. illustrating the results of experiments with oats, wheat, barley and timothy, tend to show that the danger limit for alkali of the character of that found in Montana, is above one per cent.

## DISCUSSION OF TABLES.

In the tables of analyses accompanying this bulletin are given the results of the work done in various parts of the State since the publication of Bulletin No. 18.

Samples were taken with a soil auger making a one and three-quarter inch hole, the auger bit being welded into a section of quarter inch gas pipe, attached to a proper handle. Additional sections, each three feet long, were easily added to the auger. With this instrument it was possible, except in rare cases, to take samples to a depth of eighteen feet or more. These samples were sacked and labeled in the field and forwarded to the chemical laboratory for analysis.

The results of analysis are stated in terms of chlorine, sodium sulphate and sodium carbonate.

Complete analyses of the soils were made only on rare occasions when some particular object demanded this additional work.

The chlorine proved to be very constant in amount in the various soils and it was concluded that there was no particular importance to be attached to its presence.

The alkalinity of the soil was attributed to sodium carbonate and calculated as such, even though it was conceded that the bi-carbonate might have caused the alkalinity especially at some depth. The point of importance, however, and that to be kept in mind, is that when the bi-carbonate reaches the surface it quickly changes into the harmful carbonate, hence the presence of the bi-carbonate in the soil water is a constant menace.

As has been previously stated, the question of the presence of carbonate in the soils of Montana has not except in one or two instances, proven to be of a serious one because of its small quantity.

It is to the sodium sulphate that we are to look for the cause of the injurious effects to our crop in alkali regions in our state. In the column giving the percentage of sodium sulphate present are given not sodium sulphate alone, but the equivalent in sodium sulphate of all the other sulphates present. This is done because repeated analyses from different sections showed that sulphate was the predominant salt of Montana alkali.

Comments are made on a number of samples to serve as a

basis for the treatment of any particular soil in which the reader is interested.

**Samples Nos. 1069 to 1072, inclusive, from Alex. Proffit, Manhattan.**

These show a remarkable condition to exist, namely, a good growth of grass, mainly blue stem, where the percentage of alkali is so great as to be deemed fatal to any crop. Nearly two and a half per cent in the surface foot, with one per cent in the second foot would be considered by many to be absolutely fatal to plant life, but here we have the facts.

**No. 1073.—From same field as above:** Grass very much poorer, no sign of alkali on the surface, and only twenty-eight thousandths of one per cent. sodium sulphate in the surface foot. Evidently some other reason than the presence of alkali must be sought to explain the anomalous condition. Is it that even though on lower ground than the previous plat, and yet dry, that there was a sufficient difference in its texture to account for its dry condition, while the other sample was moist? These examples show how many sided is the problem before us, and how dangerous it is to lay down any definite rules until the whole ground has been carefully studied from every possible point of view.

**No. 1074. Ditch east of the College.**

This example is cited principally to show how much salt may be present in the soil and yet not reach the surface. Over one-half per cent is present in this soil, yet there is no indication at the surface of its presence. The land has never been irrigated but even if it had been the drainage is so perfect that no accumulation of alkali would take place.

**Nos. 1075 to 1097 inclusive, from the Chas. M. Bair ranch, Canyon Creek, Yellowstone County.**

This soil shows the presence of a relatively small amount of alkali down to a depth of seven and one-half feet, so little in fact that were it all concentrated in the surface foot it would only amount to three-tenths of one per cent, too little to harm crops. From this point downward an equal distance, is found a very striking concentration of salts, and so great is the quantity, that if all the salts in the second ninety inches were collected in a single foot it would amount to over six per cent, or more than twenty times as much as is present in the upper ninety inches. Evidently any process of irrigation in which care is taken to avoid a deep penetration of the water

applied, while at the same time efforts are put forth to prevent a rise of the ground water, will prove successful as long as it attains the two objects aimed at. This ranch ought never to become "alkaline."

**Nos. 1098 to 1111 inclusive. Hesper Farm, Yellowstone County.**

The samples from the two fields included in this series are chiefly interesting from the fact that the alkali is present in very small amounts even though irrigation has been practiced here for many years and in the face of the fact that very large amounts of alkali are known to be concentrated at depths of ten to eighteen feet in the virgin soil of this section. The apparent immunity of these fields is due to reasons already pointed out.

**Nos. 1140 to 1153 inclusive. The P. B. Moss ranch, near Billings.**

The samples representing the soil in two portions of the same ranch are chiefly interesting in showing the small quantity of alkali at the surface as compared with that contained at greater depths. In a case of this kind constant attention is needed to prevent the rise of alkali and of ground water. All the elements necessary to cause infinite trouble are here present and it is to be avoided only by continuous effort. As a matter of fact, large portions of lower-lying ground on this ranch are already destroyed by the combined effects of excess of alkali and of moisture.

**Nos. 968 to 974. Gird Creek. Bitter Root Stock Farm. Gilchrist ranch.**

Here is the nearest approach to black alkali, both in its composition and its effects, that we have found in Montana. It has a distinctly injurious effect upon crops which have been tried upon it.

**Nos. 927 to 929. Three Forks.**

This is in its composition a typical "black alkali" soil also, but being in a non-cultivated section, its actual effects upon an ordinary crop could not be observed. What this effect would probably be, however, is indicated by the deep colored solution yielded by the soil when leached with water. This color is due to the solvent effect of the alkaline solution upon the humus of the soil and, of course, it would have a like solvent, and consequently damaging effect upon growing vegetation.

**Nos. 1713 to 1724. Samples from Poplar, Montana.**

These samples are mainly interesting as showing the location of the "Zone of Concentration" of the alkali and as indicating the

course to follow in treatment of the land.

**Nos. 1725 to 1744.**

These samples were taken from various points in the Milk River Valley many or all of which are involved in the "Milk River Irrigation Project." All samples taken in this region have shown a concentration of salts principally at a depth of from four to six feet. With the advent of a plentiful supply of water the danger of concentrating this alkali at the danger point, that is, in the surface foot, becomes imminent, and we strongly urge the most careful attention to the rules laid down in this bulletin.

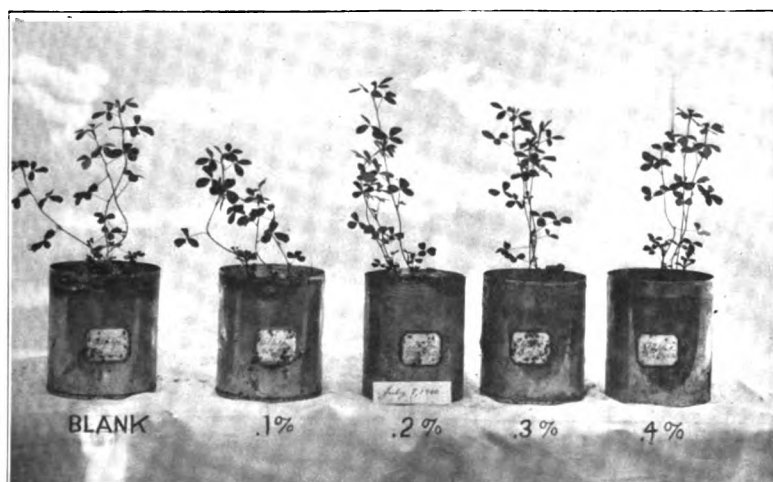
As has been previously stated only a few of the analyses made could be discussed in a bulletin of this nature. However, in case of a special interest on the part of any of the readers of this bulletin, in a particular soil, we are willing to answer any question concerning it that may arise.

My thanks are due Mr. Edmund Burke, Assistant Chemist, for invaluable aid in collecting samples, and for the work done in analyzing the greater part of the samples.

### CONCLUSION.

The Montana farmer has the control of the alkali question entirely in his own hands, and whether his farm shall be abandoned as worthless, or made to "blossom as the rose" and yield crops of enormous size, rests entirely on his intelligent management.

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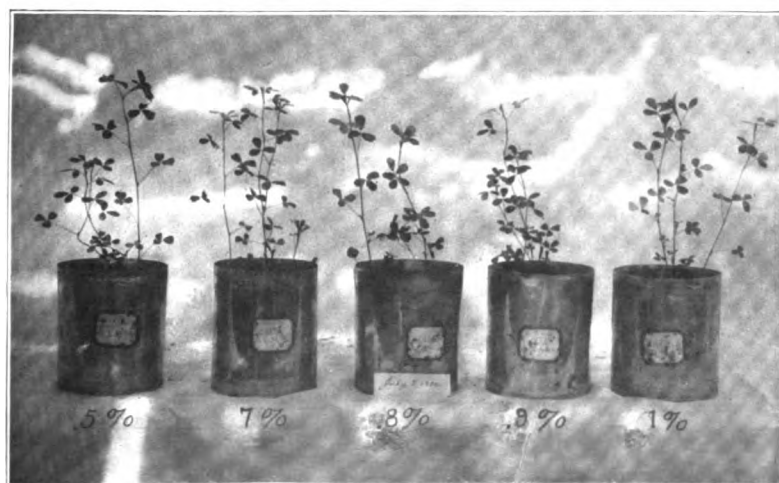
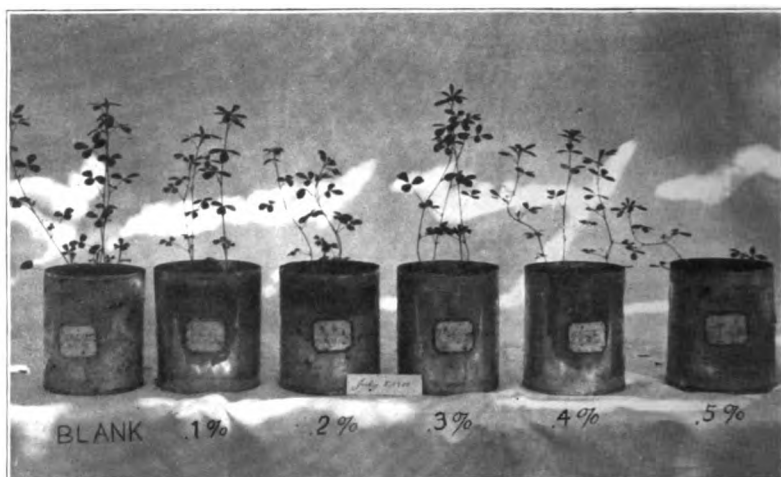


PLATE I. Experiments with alfalfa showing the effects of different proportions of magnesium sulphate.

3



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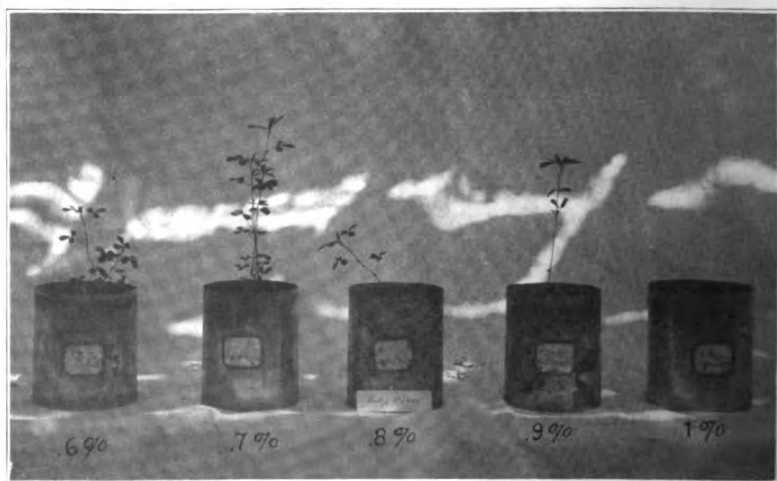
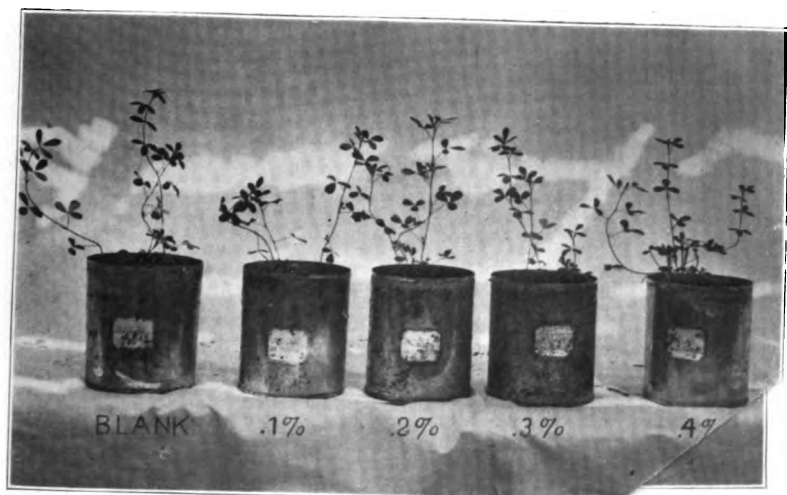


PLATE II. Experiments with alfalfa showing the effects of different proportions of sodium sulphate.

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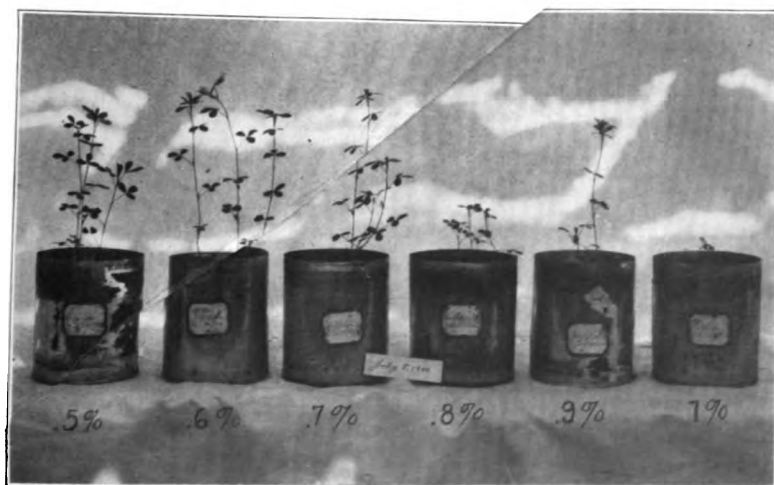
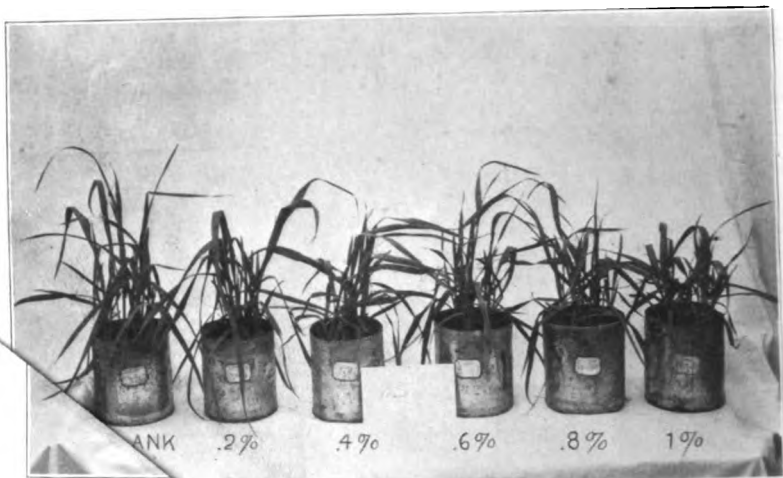


PLATE III. Experiments with alfalfa showing the effects of different proportions of "mixture."

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Experiments with wheat showing the effects of different proportions of "mixture."

8

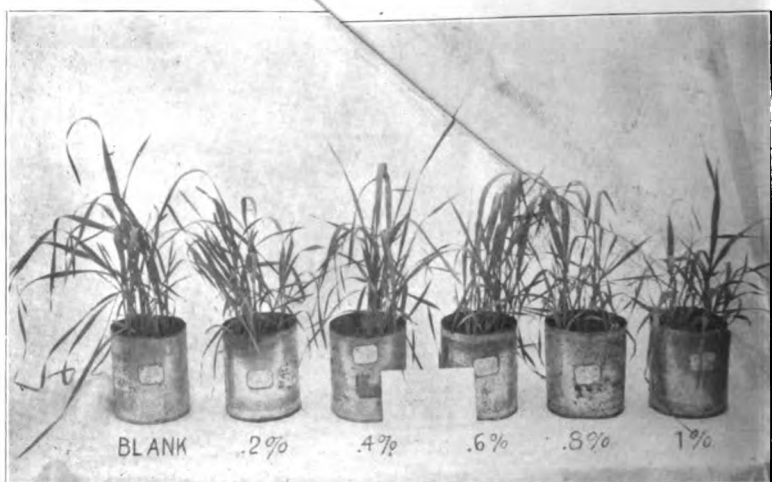
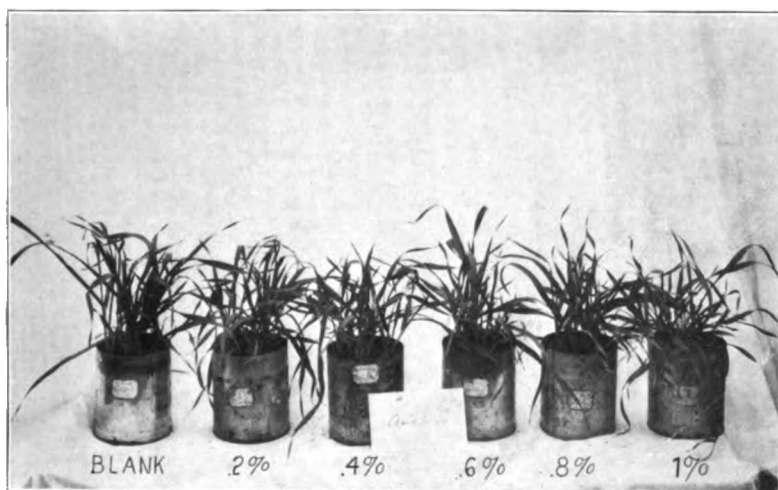


PLATE IV. Experiments with wheat showing the effects of different proportions of "mixture."

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Experiments with barley showing the effects of various proportions of "mixture."

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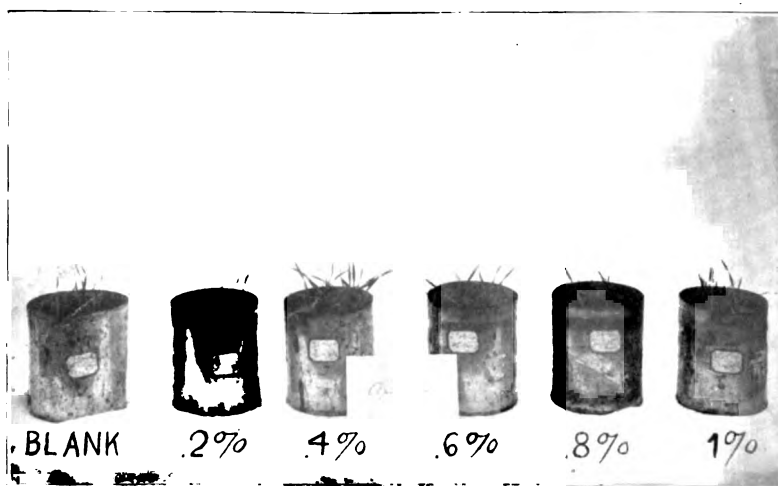


PLATE V. Experiments with timothy showing the effects of different proportions of "mixture."



TABLES OF ANALYSES.

Description	Laboratory Number	Chlorine per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
August 8, 1900.						
Smith River No 1	924		.467	.13	1st foot	
Smith River No 2.	925		.052	.11	2d foot	
Smith River No. 3	926		.037	.1	3d foot	
Three Forks No. 1	927		.135	.424	1st foot	
Three Forks No. 2	928		.06	.16	2d foot	Yield dark colored solution on treating with water.
Three Forks No. 3	929		.03	.16	3d foot	
John Pickering's ranch near Townsend.	930		.018	.037		
John Bering's bench farm.—Soll.	931		.028	.1		
John Bering's bench farm.—Subsoil.	932	Trace	12.18	.069		Surface alkali.
Gird Creek, Gilchrist ranch, Bitter Root Stock Farm.	968	.0176	.003	.1	1st foot	
	969	.035	.0348	.159	2d foot	
	970	.035	.0186	.182	3d foot	
	971	.0176	.0246	.1749	4th foot	
	972	.035	.0234	.1484	5th foot	
	973	.0176	.0174	.0848	6th foot	
	974	.0176	.0048	.09		
Bitter Root Stock Farm, greenhouse orchard.	975	.0176	.0066	.053	1st foot	
	976	.0176	.0024	.053	12-18 in.	Gravel.
	977	.0176	.0294	.0583	1st foot	
	978	.035	.0146	.0795	2d foot	
	979	.0176	.0102	.0848	3d foot	Gravel.
Bitter Root Stock Farm, Lot's place under bench.	980	.0176	.0258	.0477	1st foot	
	981	.0176	.0552	.0689	2d foot	
	982	.035	.0696	.1325	3d foot	
	983	.0176	.0612	.18	4th foot	
	984	.0176	.0528	.34	5th foot	
	985	.0176	.0402	.127	6th foot	Gravel.
	986	.0176	.012	.053		

TABLES OF ANALYSES.

Description	Laboratory Number	Chlorine per cent.	Depth		Remarks
			Sodium Sulphate per cent.	Sodium Carbonate per cent.	
John L. Humble, north of Corvallis.	987	.0176	.0096	.0424	Loam 4 ft. to sand, 4 1/4 gravel.
Fred Wehr, Corvallis.	988	.0088	.006	.037	Fine earth 3%; rejections 1 1/2 oz.
Curlaw Mining Co., Orchard, Victor,	989	.0088	.0036	.0265	Granite soil, fine 2 lbs. 13 oz., rejs. 2 lbs. 8 oz.
W. Parkhurst, Corvallis.	990	.0176	.0048	.0848	Fine soil, sandy to 6 ft. Fine earth 3 lbs. 5 oz, rejs. 2 oz.
Bitter Root Stock Farm— 30 acre-orchard.	991	.0176	.0120	.0477	Fine earth 3lbs. 10 1/2 oz.; rejs. 10 oz.
Gilchrist orchard; trees dead.	992	.088	.1386	.0742	Fine earth 3 lbs. 6 1/4 oz.; rejs. 3 oz.
East Orchard, foot hills, 25 acre.	993	.0088	.0060	.0318	Fine earth 3 lbs. 11 oz.; rejs. 14 1/2 oz.
Pendergast.	994	.0088	.0108	.0424	Fine earth 2 lbs. 1 1/2 oz.; rejs. 7 1/2 oz.
Hospital orchard, 10 acres 2000 trees	995	.0088	.0072	.0477	Fine earth 4 lbs 6 1/2 oz rej 6 oz.
Sugar-beet field, 60 acre orchard.	996	.0176	.0138	.0477	Fine earth 3 lbs. 12 oz.
100 acre orchard bench.	997	.0176	.0114	.0583	Rejections 8 1/2 oz.
September 6, 1899.	1069	.1	2.408	.082	Mixed grass meadow mainly blue stem
Alex. Proffitt, near forks of Gallatin,	1070	.05	.992	.0212	alkali showing in few places good
about 4 miles north of Manhattan.	1071	.0184	.545	.0583	growth. Irrigated in June.
	1072	.0092	.199	.0422	
Same field, lower ground, (a sag.)	1073	.0092	.028	.0477	Dry. Grass very much poorer.
					No signs of alkali on surface.
From ditch dug east of College for city water pipes.	1074	.0092	.527	.1113	



TABLES OF ANALYSES.

Description	Laboratory Number	Chlorine per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
Blue stem natural meadow under high line ditch.	1110	.004	.012	.069	1st foot	Not yet irrigated. Soil too dry and pulverulent to sample to depth.
	1111	.011	.448	.0424	2d foot	
Billings Estate, section 17, 100 yards southeast of east. Hesper farm gate.	1112	.009	.156	.0583	1st foot	Blue stem and sweet clover.
	1113	.006	.114	.069	2d foot	
	1114	.005	.138	.053	3d foot	
	1115	.005	.137	.0583	4th foot	
	1116	.004	.08	.0583	5th foot	
	1117	.004	.082	.0583	6th foot	
Billings Estate, 100 yards northeast of the Hesper farm gate.	1118	.003	.00	.0371	1st foot	Depression in which water has stood and in which grass is very green. At end of 1st foot moist.
	1119	.002	.00	.0583	2d foot	
	1120	.002	.00	.067	3d foot	
	1121	.003	.00	.064	4th foot	
Hesper Farm, blue stem field, 100 yards from lane and 100 yards from east side of farm.	1122	.002	.00	.0583	1st foot	
	1123	.002	.00	.053	2d foot	
	1124	.005	.00	.064	3d foot	
	1125	.002	.008	.053	4th foot	
	1126	.00	.051	.053	1st foot	
Hesper Farm Alfalfa field, 100 yards north of lane and 100 yards west of road.	1127	.002	.168	.059	2d foot	
	1128	.003	.174	.064	3d foot	
	1129	.007	.123	.059	4th foot	
	1130	.004	.207	.059	5th foot	
	1131	.007	.347	.059	6th foot	
	1132	.055	1.052	.0371	1st foot	
100 yards east of Shiloh school house, Yellowstone county.	1134	.035	.767	.053	2d foot	Blue stem meadow.
	1135	.012	.258	.069	2 1/4 ft.	
	1133	.736	23.308	.0213		
Effluence from above locality.						

Same field, 112 yards south of north line of field. Patch showing efflorescence.	1136	.034	.25	.048	1st foot	Water.
	1137	.050	.485	.0583	2d foot	
	1138	.041	.968	.0424	3d foot	
	1139	.036	1.065	.048	4th foot	
P. B. Moss ranch Yellowstone county	1140	.024	.037	.048	1st foot	Lower portion coarse sand.
	1141	.012	.019	.0583	2d foot	
	1142	.007	.014	.0583	3d foot	
	1143	.008	.013	.0583	4th foot	
	1144	.014	.088	.0583	5th foot	
	1145	.017	.096	.0583	6th foot	
	1146	.029	.146	.053	7th foot	
	1147	.016	.252	.048	8th foot	
	1148	.019	.366	.0424	9th foot	
P. B. Moss ranch, Alfalfa field below ditch. Sept. 1, 1900.	1149	.009	.091	.0583	1st foot	Below ditch good growth.
	1150	.005	.433	.053	2d foot	
	1151	.012	.551	.048	3d foot	
	1152	.011	.59	.048	4th foot	
	1153	.011	.453	.053	5th foot	
Efflorescence from sides of Bozeman City water ditch.	1154		12.21			
April 20, 1900.						
Sunny Side Stock Farm. T. C. Power.	1175	.19	.0567	.18		
Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
Fort Ellis Reservation— Bunch grass meadow Oat field west of road. Fall wheat east of road Spring wheat east of road Spring wheat west of road.	1353	.0016	.015	.0107		General sample.
	1354	.013	.023	.0053		General sample.
	1355	.0016	Trace	.0053		General sample.
	1356	.0016	Trace	.01		General sample.
	1357	.0033	Trace	.01		General sample.

TABLES OF ANALYSES.

Description	Laboratory Number	Chlorine per cent.	Depth		Remarks
			Sodium Sulphate per cent.	Sodium Carbonate per cent.	
J. W. Strevell, Miles City— General sample alfalfa field. Gumbo soil, near Beck's Sugar beets last year alfalfa this year. Alkali spot, very moist slough.	1437	.0356	.0158	.037	
	1438	.0089	.039	.11	
	1439	.0053	.0268	.0477	1st foot
	1440	.0035	.0177	.0424	2d foot
	1441	.0017	1.50	.0212	1st foot
	1442	.0089	.62	.0265	2d foot
W. B. Jordan, Miles City,— General samples cracked surface soil Dry hard pan from 18-24 Dry hard pan from 24-30 Red Top ranch, grease wood surrounded by bare spot	1443	.0089	.516	.0318	3d foot
	1444	.0017	.048	.0795	Red Top ranch, subsoiled 2 years ago.
	1445	.0071	.375	.053	Moist.
	1446	.0017	.71	.0477	3-12 in
	1447	.0071	.40	.053	2d foot
	1448	.0071	.082	.116	3d foot
Homer Squyer, Wibaux	1449	.0089	.0158	.037	25 feet from No. 1448.
	1450	.0089	.0115	.037	Fine growth of alfalfa.
	1451	.0089	.0146	.053	1st foot
	1452	.0053	.078	.053	2d foot
	1453	.0089	.70	.0265	3d foot
	1454	.0071	.49	.0318	4th foot
Wm. H. Ellis, Bozeman,— 80 acre field, summer fallow Northeast corner near alkali spot Northeast corner near alkali spot	1455	.0071	.111	.0212	5th foot
	1456	.0089	.048	.0159	6th foot
	1457	.0053		.0106	7th foot
	1458	.0089		.0212	General sample. Field sowed to timothy and alsike.
	1459	.0071		.0265	Summer fallow yield good.
					1st foot
					2d foot

Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
Northeast corner near alkali spot	1460	.0035		.0818	3d foot	Gravel and water. General surface sample for alkali.
Northeast corner near alkali spot	1461	.0035		.0265	36-42 in	
Northeast corner near alkali spot	1462	.0025	.051	.0212	1st foot	
Alkali spot	1463	.0356	.032	.0371	2d foot	2 1/2 ft water, 3 ft. to gravel.
Alkali spot	1464	.0053	1.08	.0265	3d foot	
Alkali spot	1465	.0071	.45	.037	1st foot	
W. H. Ellis, Bozeman, Aug. 8, 1900.—						
8 acre field.	1466	.0125		.053	2d foot	General sample.
8 acre field.	1467	.024		.011	3d foot	
8 acre field.	1468	.0142		.026	1st foot	
8 acre field.	1469	.0071		.016	2d foot	General sample; soil 18in. Gravel.
80 acre field	1470	.0071		.0106	24-30 in.	
80 acre field	1471	.0035		.016		
80 acre field	1472	.0035		.037		
Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
Clover field, general sample	1473	.0033	.0067		1st foot	4 1/2 ft. to gravel. General sample.
Clover field, general sample	1474	.0033	.10	.037	2d foot	
Clover field, general sample	1475	.0066	.26	.075	3d foot	
Clover field, general sample	1476	.013	.42	.075	4th foot	
Clover field, general sample	1477	.0098	.076	.064	5th foot	
Clover field, general sample	1478	.013	.09	.064		
40 acre pasture near middle of field	1479	.0033	Trace	.021		
Pasture timothy and alsike.	1480	.0033	Trace	.032		
	1481	.06	Trace	.032		
H. Farris, Red Bluff.	1482	.0033	Trace	.021		
Riverside Park Great Falls,—						
about roots of dead trees.	1683	.35	.49	.037	1st foot	
about roots of dead trees.	1684	.267	.48	.037	2d foot	
about roots of dead trees.	1685	.123	.30	.037	3d foot	
about roots of dead trees.	1686	.126	.289	.043		

TABLES OF ANALYSES.

Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
East of cornfield opposite R. R. depot, Poplar, Montana. 30 yards south of track.	1713	.007	.002	.058	1st foot	
	1714	.01	.04	.064	2d foot	
	1715	.01	.036	.059	3d foot	
	1716	.012	.61	.053	4th foot	
	1717	.012	1.72	.037	5th foot	
	1718	.016	.238	.101	6th foot	
	1719	.051	.166	.096	7th foot	
	1720	.21	.335	.075	8th foot	
	1721	.014	.102	.096	9th foot	
	1722	.009	.079	.096	10th foot	
Alfalfa field W. M. Wooldridge, Chinook, Mont. Section 27.	1723	.016	.079	.112	11th foot	Water 12 ft.
	1724	.009	.098	.112	12th foot	
	1725	.008	.027	.048	1st foot	
	1726	.003	.028	.053	2d foot	
Poplar, Mont., corn field, gen. sample.	1727	.005	.06	.053	3d foot	
	1728	.026	.125	.043	4th foot	
	1729	.007	.075	.033	5th foot	
	1730	.015	.166	.032	6th foot	
	1731	.024	.42	.021	7th foot	
	1732	.049	.436	.021	8th foot	
	1733	.033	.174	.032	9th foot	
	1734	.0115	.033	.037		
Oat field of W. M. Wooldridge, Chinook	1735	.010	.032	.043	1st foot	
	1736	.0115	.13	.048	2d foot	
	1737	.051	.096	.048	3d foot	
	1738	.008	.213	.037	4th foot	
	1739	.007	.32	.048	5th foot	

Burns' oat field. Empire Cattle Co. Chinook, Mont.	1740	.01	.038	.048	1st foot
	1741	.021	.085	.048	2d foot
	1742	.033	.168	.069	3d foot
	1743	.082	.44	.048	4th foot
	1744	.074	1.48	.021	5th foot
Road near Burns' house. Chinook.	1745	3.34	9.84	.128	Surface alkali.
McC Winiger, Kallispell,— Acme Dairy Farm, North Middle field.	2067	.013	Trace	.074	1st foot
	2068	.012	Trace	.032	2d foot
	2069	.013	Trace	.032	3d foot
	2070	.012	Trace	.037	4th foot
	2071	.009	Trace	.037	1st foot
Sec. 31 T 29 N R 20 W.	2072	.013	Trace	.037	2d foot
	2073	.017	Trace	.116	3d foot
	2074	.013	Trace	.111	4th foot
	2075	.013	Trace	.069	2d foot
	2076	.013	Trace	.058	3d foot
Bottom Land	2077	.013	Trace	.069	4th foot
	2078	.012	Trace	.100	
	2079	.009	.050	.053	1st foot
White Streak, 1 inch thick.	2080	.017	.064	.069	2d foot
	2081	.017	.222	.037	3d foot
	2082	.009	.011	.042	1st foot
L. A. Dorres, Malta,— Gumbo and alkali.	2083	.009	.023	.042	2d foot
	2084	.010	.026	.048	3d foot
	2085	.012	.046	.037	4th foot
	2086	.015	.039	.048	5th foot
	2087	.015	.050	.048	6th foot
	2088	.015	.074	.042	7th foot
	2089	.013	.079	.058	8th foot
	2082	.009	.011	.042	1st foot
R. M. Trafton, Malta,— Sec. 18 T 30 N R 30 E.	2083	.009	.023	.042	2d foot
	2084	.010	.026	.048	3d foot
	2085	.012	.046	.037	4th foot
Pumping plant, Hooker & Caldwell, St. Louis. Lift 30 ft. from Milk River. 4500 gals. per minute. No signs of alkali.	2086	.015	.039	.048	5th foot
	2087	.015	.050	.048	6th foot
	2088	.015	.074	.042	7th foot
	2089	.013	.079	.058	8th foot
	2082	.009	.011	.042	1st foot

TABLES OF ANALYSES.

Description	Laboratory Number	Depth			Remarks
		Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	
Great Northern Demonstration plats, Ashfield.	2090	.013	.032	.032	
	2100	.018	.067	.048	
	2101	.018	.404	.032	
	2102	.013	.815	.042	
Great Northern Demonstration plats, Hinsdale.	2103	.005	.320	.048	Gumbo.
	2104	.007	.026	.053	Sand.
	2105	.017	.047	.053	Sand.
	2106	.007	.432	.042	Gravel, local.
James Deegan,— Bottom land, 2½ miles east of Hins- dale.	2107	.003	.019	.042	1st foot
	2108	.002	.015	.037	2d foot
	2109	.002	Trace	.032	3d foot
	2110	.010	Trace	.026	1st foot
W. M. Wooldridge,— Bottom land east of Hinsdale.	2111	.017	.061	.037	2d foot
	2112	.017	.124	.037	3d foot
	2113	.017	.067	.053	4th foot
	2114	.013	.127	.026	5th foot
J. W. Davis, Hinsdale.	2115	.007	.020	.058	1st foot
	2116	.018	.022	.058	2d foot
	2117	.020	.232	.053	3d foot
Lower Rock Creek Bottom, Hinsdale.	2118	.018	.646	.082	1st foot
	2119	.015	.373	.032	2d foot
	2120	.013	.541	.032	3d foot
	2121	.013	.127	.042	4th foot
	2122	.012	.140	.048	5th foot
					Alkali.

August Schwang, Hinsdale.	2123 .010	.065	.037	1st foot	Water stands at surface in spring.
	2124 .009	.705	.021	2d foot	
	2125 .009	.715	.032	3d foot	
Chas. Newmage, Hinsdale.	2126 .010	.026	.042	1st foot	
	2127 .010	.170	.032	2d foot	
	2128 .009	.213	.037	3d foot	
	2129 .010	.188	.048	4th foot	
	2130 .010	.690	.037	5th foot	
T. C. Power ranch, Sun River back of Turnell place.—	2131 .007	.625	.64	1st foot	Clayey soil.
Alfalfa poor, moist and clayey.	2132 .009	1.317	.048	2d foot	Surface cracked.
Alfalfa poor, moist and clayey.	2133 .009	1.656	.048	3d foot	
300 yds. S.W. preceding, soil loose moist.	2134 .009	.545	.048	1st foot	
Peppergrass and foxtail in possession	2135 .009	Trace	.058		Alfalfa, timothy and grain, all failed. mechanical condition perfect.
Flume piece. Excellent soil, alfalfa fine.	2136 .009	.014	.090	1st foot	
Sand.	2137 .003	.016	.058	2d foot	
Isaac Sears, near Plains,—					Sandy pulverulent.
Best orchard soil.	2138 .003	Trace	.064	1st foot	
Best orchard soil.	2139 .007	.005	.053	2d foot	
Best orchard soil.	2140 .009	Trace	.064	2½ feet	To gravel.
General sample of above.	2141 .003	Trace	.021		Extra good soil, fine texture. Bakes.
Garden patch.	2142 .003	Trace	.011		
Orchard soil, nothing but apples do well.	2143 .003	.008	.011		
A. L. Trent and Clayton, Plains.	2144 .023	.005	.021		Gained apple prize at Kalispell in 1900
Mrs. Lizzie Lynch, Plains,—					Gravel, interfering with boring.
Fine timothy meadow.	2145 .004	Trace	.095		
M. H. Pierce, Plains.—					
Garden patch, soil 18 ins. deep below slide rock hill.	2146 .007	.020	.032		Beneath, dark loam, potatoes
Near above in Blackberry patch.	2147 .018	.083	.026		White efflorescence.

## TABLES OF ANALYSES.

Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
Lorenz Helterlein, Plains, — Barley field, S.E. $\frac{1}{4}$ Sec. 21, T 20, R 26 W.	2148	.003	Trace	.026	1st foot	Fine sandy soil. Valley unirrigated, drought this year.
	2149	.003	Trace	.016	2d foot	
	2150	.003	.005	.026	3d foot	
M. H. Pierce, Plains.— S.W. $\frac{1}{4}$ Sec 22 T 20 N. R. 26 W.	2151	.005	Trace	.016	1st foot	
	2152	.005	Trace	.026	2d foot	
	2153	.003	Trace	.048	3d foot	
	2154	.003	.005	.069	4th foot	
	2155	.005	Trace	.133	5th foot	
	2156	.009	Trace	.133	6th foot	
	2157	.005	Trace	.10	7th foot	
	2158	.005	Trace	.08	8th foot	
	2159	.003	Trace	.106	9th foot	
	2160	.003	Trace	.032	10th foot	
J. R. Willis, Plains.— S. E. $\frac{1}{4}$ Sec. 27 T. 20 N. R. 26 W.	2161	.004	Trace	.154	1st foot	Gravel 10 to 12 ft., Coarse sand.
	2162	.009	.034	.143		
	2163	.007	.015	.143		
	2164	.003	.011	.138		
	2165	.007	.007	.074	5th foot	
C. C. Willis, Plains.— N. W. $\frac{1}{4}$ Sec. 27 T. 20 N. R. 26 W.	2166	.002	Trace	.026		
	2167	.003	Trace	.053		
	2168	.002	.61	.048		
	2169	.005	Trace	.087		
	2170	.003	Trace	.053		
J. Beckstead, Warm Springs.— 25 yds, N. hay corral.	2171	.081	1.047	.17	1st foot	Almost nothing growing.
	2172	.021	.160	.18	2d foot	

75 yds. S. E. corral.	2173	.017	.244	.085	3d foot	Gravel
	2174	.010	.102	.106	1st foot	Fine crop hay.
	2175	.009	.060	.074	2d foot	
	2176	.007	.041	.064	3d foot	
	2177	.005	.041	.064	4th foot	Gravel.
Bitter Root Stock Farm.— sandy, one of the best soils.						
Hamilton No. 3.	2182	.005	Trace	.032		Gravel 1ft., beets 20 tons per a., topped
Hamilton No. 2.	2183	.003	.040	.016		Gravelly soil, 4 tons topped.
West side.	2184	.004	Trace	.092		Sandy loam, 12 tons.
Pendergast No. 1.	2185	.004	.013	.074		Alkali bottom, 15 tons.
Pendergast No. 1.	2186	.126	.459	.085	1st foot	
	2187	.010	.034	.175	18 in	Gravel.
Gilchrist No. 1.	2188	.010	.020	.133	1st foot	
Gilchrist No. 1.	2189	.012	.029	.122	2d foot	
Gilchrist No. 1.	2190	.010	Trace	.085	3d foot	
Gilchrist No. 1.	2191	.012	.022	.053		
Gilchrist No. 2.	2192	.005	Trace	.042		General
Upper Ward No. 1.	2193	.003	.041	.037		High land former orchard 10 to 12 ton.
Upper Ward No. 1.	2194	.003	Trace	.053		Some alkali.
Upper Ward No. 1.	2195	.005	Trace	.016		General sample.
Lower Ward 1.	2196	.003	Trace	.026		Shallow soil 10 in. to gravel, 16 tons
Ravall 1.	2197	.007	.038	.021		beets.
						Good soil 15 tons.
Rev. Wm. Cobleigh, Corvallis.	2198	.007	Trace	.037	1st foot	
Rev. Wm. Cobleigh, Corvallis.	2199	.007	Trace	.058	2d foot	Gravel.
Corvallis 1.	2200	.003	Trace	.021		Old feed corral, good yield.
Hamilton No. 4.	2201	.003	Trace	.053		Poor beets, very small.
Hamilton No. 1.	2202	.003	Trace	.053		Good beets.

## SOILS FROM EXPERIMENT STATION.

Description	Laboratory Number	Phosphoric acid, per cent	Potash per cent	Sodium Sulphate per cent
Location No. 4. Clover field, 20 acres, S. W. corner of farm, soil 12 in deep, Gravel 4 feet 3 inches.	680	.16	.276	.015
Subsoil of above.	681	.17	.159	.017
Location No. 5. Clover field west of Station building, soil 12 inches deep, heads of clover mostly dead in small patch, rest of plant thrifty.	691	.14	.269	.017
Clover left for seed, 1st foot.	683			.08
Clover left for seed, 2nd foot	684			.04
Clover left for seed 3rd foot.	685			.023
Clover left for seed 4th foot.				
Location No. 6. Clover N. W. corner of farm, moister than location No. 5. Gravel and water 3 feet.	691	.14	.269	.01
Subsoil of 691	692	.17	.163	.015
Silt from north end of farm on beet plat.	693	.17	.219	.01
Rotation plats. No. 1. Wheat. Gravel 3 feet 9 inches. Soil 12 inches.	694	.18	.300	.013
Rotation plat No. 2. Peas. Gravel 4 ft. 6 in. Soil 10 inches deep.	695	.17	.284	.006
Rotation plats No. 3. Oats. Gravel 3 ft., 6 in. Soil 9 in. deep.	696	.16	.223	.017

Rotation plats No. 4. Beets. Gravel 3 ft. 9 in. Soil 10 in. deep.	697 .17	.238	.009
Rotation plats No. 5. Barley. Gravel 3 feet 9 inches. Soil 8 inches deep.	698 .157	.206	.005
Rotation plats No. 6. clover. Gravel 4 feet 3 in. Soil 12 in. deep.	699 .15	.211	.01
Subsoil of 694	700 .17		.005
Subsoil of 695.	701 .15	.213	
Subsoil of 696	702 .14	.168	.005
Subsoil of 697	703 .158	.291	.001
Subsoil of 698	704 .16	.165	.009
Subsoil of 699.	705 .16	.180	.024

TABLES OF ANALYSES.

Description	Laboratory Number	Chlorine per cent.	Depth		Remarks
			Sodium Sulphate per cent.	Sodium Carbonate per cent.	
J. W. Strevell, Miles City— General sample alfalfa field. Gumbo soil, near Beck's Sugar beets last year alfalfa this year. Alkali spot, very moist slough.	1437	.0356	.0158	.037	
	1438	.0089	.039	.11	
	1439	.0053	.0268	.0477	1st foot
	1440	.0035	.0177	.0424	2d foot
	1441	.0017	1.50	.0212	1st foot
	1442	.0089	.62	.0265	2d foot
	1443	.0089	.516	.0318	3d foot
W. B. Jordan, Miles City,— General samples cracked surface soil Dry hard pan from 18-24 Dry hard pan from 24-30 Red Top ranch, grease wood surrounded by bare spot	1444	.0017	.048	.0795	Red Top ranch, subsoiled 2 years ago.
	1445	.0071	.375	.053	Moist.
	1446	.0017	.71	.0477	3-12 in
	1447	.0071	.40	.053	2d foot
	1448	.0071	.082	.116	3d foot
	1449	.0089	.0158	.037	25 feet from No. 1448.
					Fine growth of alfalfa.
Homer Squyer, Wilbaux	1450.	.0089	.0115	.037	
	1451	.0089	.0146	.053	1st foot
	1452	.0053	.078	.053	2d foot
	1453	.0089	.70	.0265	3d foot
	1454	.0071	.49	.0318	4th foot
	1455	.0071	.111	.0212	5th foot
	1456	.0089	.048	.0159	6th foot
Wm. H. Ellis, Bozeman,— 80 acre field, summer fallow Northeast corner near alkali spot Northeast corner near alkali spot	1457	.0053	.0106		7th foot
					General sample. Field sowed to timothy and alsike.
	1458	.0089	.0212		Summer fallow yield good.
	1459	.0071	.0265		1st foot

Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
Northeast corner near alkali spot	1460	.0035		.0318	3d foot	Gravel and water. General surface sample for alkali.
Northeast corner near alkali spot	1461	.0035		.0265	36-42 in	
Northeast corner near alkali spot	1462	.0025	.051	.0212	1st foot	
Alkali spot	1463	.0356	.032	.0371	2d foot	2 ½ ft water, 3 ft. to gravel.
Alkali spot	1464	.0053	1.08	.0265	3d foot	
Alkali spot	1465	.0071	.45	.037	1st foot	
W. H. Ellis, Bozeman, Aug. 8, 1900.—						
8 acre field.	1466	.0125		.053	1st foot	General sample.
8 acre field.	1467	.024		.011	2d foot	
8 acre field.	1468	.0142		.026	3d foot	
8 acre field.	1469	.0071		.016	1st foot	General sample. General sample; soil 18in. Gravel.
80 acre field	1470	.0071		.0106	2d foot	
80 acre field	1471	.0035		.016	24-30 in.	
80 acre field	1472	.0035		.037		
Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
Clover field, general sample	1473	.0033	.0067		1st foot	4½ ft. to gravel. General sample.
Clover field, general sample	1474	.0033	.10	.037	2d foot	
Clover field, general sample	1475	.0066	.26	.075	3d foot	
Clover field, general sample	1476	.013	.42	.075	4th foot	
Clover field, general sample	1477	.0098	.076	.064	5th foot	
Clover field, general sample	1478	.013	.09	.064		
40 acre pasture near middle of field	1479	.0033	Trace	.021		
Pasture timothy and alsike.	1480	.0033	Trace	.032		
	1481	.06	Trace	.032		
H. Farris, Red Bluff.	1482	.0033	Trace	.021		
Riverside Park Great Falls,—						
about roots of dead trees.	1683	.35	.49	.037	1st foot	
about roots of dead trees.	1684	.267	.48	.037	2d foot	
about roots of dead trees.	1685	.123	.30	.037	3d foot	
about roots of dead trees.	1686	.126	.289	.043		

## TABLES OF ANALYSES.

Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
East of cornfield opposite R. R. depot, Poplar, Montana. 30 yards south of track.	1713	.007	.002	.058	1st foot	
	1714	.01	.04	.064	2d foot	
	1715	.01	.036	.059	3d foot	
	1716	.012	.61	.053	4th foot	
	1717	.012	1.72	.037	5th foot	
	1718	.016	.238	.101	6th foot	
	1719	.051	.166	.096	7th foot	
	1720	.21	.335	.075	8th foot	
	1721	.014	.102	.096	9th foot	
	1722	.009	.079	.096	10th foot	
	1723	.016	.079	.112	11th foot	
	1724	.009	.098	.112	12th foot	Water 12 ft.
Alfalfa field W. M. Wooldridge, Chinook, Mont. Section 27.	1725	.008	.027	.048	1st foot	
	1726	.003	.028	.053	2d foot	
	1727	.005	.06	.053	3d foot	
	1728	.026	.125	.043	4th foot	
	1729	.007	.075	.033	5th foot	
	1730	.015	.166	.032	6th foot	
	1731	.024	.42	.021	7th foot	
	1732	.049	.436	.021	8th foot	
	1733	.033	.174	.032	9th foot	
Poplar, Mont., corn field, gen.l sample.	1734	.0115	.033	.037		
Oat field of W. M. Wooldridge, Chinook	1735	.010	.032	.043	1st foot	
	1736	.0115	.13	.048	2d foot	
	1737	.051	.096	.048	3d foot	
	1738	.008	.213	.037	4th foot	
	1739	.007	.32	.048	5th foot	

Burns' oat field, Empire Cattle Co. Chinook, Mont.	1740	.01	.038	.048	1st foot
	1741	.021	.085	.048	2d foot
	1742	.033	.168	.069	3d foot
	1743	.082	.44	.048	4th foot
	1744	.074	1.48	.021	5th foot
Road near Burns' house, Chinook.	1745	3.34	9.84	.128	Surface alkali.
McC Winiger, Kalispell,— Acme Dairy Farm, North Middle field.	2067	.013	Trace	.074	1st foot
	2068	.012	Trace	.032	2d foot
	2069	.013	Trace	.032	3d foot
	2070	.012	Trace	.037	4th foot
	2071	.009	Trace	.037	1st foot
Sec. 31 T 29 N R 20 W.	2072	.013	Trace	.037	2d foot
	2073	.017	Trace	.116	3d foot
	2074	.013	Trace	.111	4th foot
	2075	.013	Trace	.069	2d foot
	2076	.013	Trace	.058	3d foot
White Streak, 1 inch thick.	2077	.013	Trace	.069	4th foot
	2078	.012	Trace	.100	
Bottom Land	2075	.013	Trace	.069	2d foot
	2076	.013	Trace	.058	3d foot
	2077	.013	Trace	.069	4th foot
	2078	.012	Trace	.100	
L. A. Dorres, Malta,— Gumbo and alkali.	2079	.009	.050	.053	1st foot
	2080	.017	.064	.069	2d foot
	2081	.017	.222	.037	3d foot
	2082	.009	.011	.042	1st foot
R. M. Trafton, Malta,— Sec. 18 T 30 N R 30 E.	2083	.009	.023	.042	2d foot
	2084	.010	.026	.048	3d foot
	2085	.012	.046	.037	4th foot
	2086	.015	.039	.048	5th foot
	2087	.015	.050	.048	6th foot
	2088	.015	.074	.042	7th foot
	2089	.013	.079	.058	8th foot
					Pumping plant, Hooker & Caldwell, St. Louis. Lift 30 ft. from Milk River. 4500 gals. per minute. No signs of alkali.

TABLES OF ANALYSES.

Description	Laboratory Number	Depth			Remarks
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Great Northern Demonstration plats, Ashfield.	2090	.013	.032	.032	
	2100	.018	.067	.048	
	2101	.018	.404	.032	
	2102	.013	.815	.042	
Great Northern Demonstration plats, Hinsdale.	2103	.005	.320	.048	Gumbo.
	2104	.007	.026	.053	Sand.
	2105	.017	.047	.053	Sand.
	2106	.007	.432	.042	Gravel, local.
James Deegan,— Bottom land, 2½ miles east of Hins- dale.	2107	.003	.019	.042	1st foot
	2108	.002	.015	.037	2d foot
	2109	.002	Trace	.032	3d foot
W. M. Wooldridge,— Bottom land east of Hinsdale.	2110	.010	Trace	.026	1st foot
	2111	.017	.061	.037	2d foot
	2112	.017	.124	.037	3d foot
	2113	.017	.067	.053	4th foot
	2114	.013	.127	.026	5th foot
J. W. Davis, Hinsdale.	2115	.007	.020	.058	1st foot
	2116	.018	.022	.058	2d foot
	2117	.020	.232	.053	3d foot
Lower Rock Creek Bottom, Hinsdale.	2118	.018	.646	.082	1st foot
	2119	.015	.373	.032	2d foot
	2120	.013	.541	.032	3d foot
	2121	.013	.127	.042	4th foot
	2122	.012	.140	.048	5th foot

August Schwang, Hinsdale.						Water stands at surface in spring.	
						1st foot	2d foot
2123	.010	.065	.037			3d foot	
2124	.009	.705	.021				
2125	.009	.715	.032				
Chas. Newmage, Hinsdale.							
2126	.010	.026	.042			1st foot	
2127	.010	.170	.032			2d foot	
2128	.009	.213	.037			3d foot	
2129	.010	.188	.048			4th foot	
2130	.010	.690	.037			5th foot	
T. C. Power ranch, Sun River back of Turnell place.—							
2131	.007	.625	.64			1st foot	Clayey soil.
2132	.009	1.317	.048			2d foot	
2133	.009	1.656	.048			3d foot	
2134	.009	.545	.048			1st foot	Surface cracked.
2135	.009	Trace	.058				Alfalfa, timothy and grain, all failed.
2136	.009	.014	.090			1st foot	mechanical condition perfect.
2137	.003	.016	.058			2d foot	
Isaac Sears, near Plains.—							
2138	.003	Trace	.064			1st foot	Sandy pulverulent.
2139	.007	.005	.053			2d foot	
2140	.009	Trace	.064			2½ feet	To gravel.
2141	.003	Trace	.021				Extra good soil, fine texture.
2142	.003	Trace	.011				Bakes.
2143	.003	.008	.011				
A. L. Trent and Clayton, Plains.							
2144	.023	.005	.021				Gained apple prize at Kallispell in 1900
Mrs. Lizzie Lynch, Plains.—							
2145	.004	Trace	.095				Gravel, interfering with boring.
M. H. Pierce, Plains.—							
2146	.007	.020	.032				Beneath, dark loam, potatoes.
2147	.018	.083	.026				White efflorescence.

## TABLES OF ANALYSES.

Description	Laboratory Number	Sodium Chloride per cent.	Sodium Sulphate per cent.	Sodium Carbonate per cent.	Depth	Remarks
Lorenz Helterlein, Plains,— Barley field, S.E. ¼ Sec. 21, T 20, R 26 W.	2148	.003	Trace	.026	1st foot	Fine sandy soil.
	2149	.003	Trace	.016	2d foot	Valley unirrigated, drought this year.
	2150	.003	.005	.026	3d foot	
M. H. Pierce, Plains.— S.W. ¼ Sec 22 T 20 N. R. 26 W.	2151	.005	Trace	.016	1st foot	
	2152	.005	Trace	.026	2d foot	
	2153	.003	Trace	.048	3d foot	
	2154	.003	.005	.069	4th foot	
	2155	.005	Trace	.133	5th foot	
	2156	.009	Trace	.133	6th foot	
	2157	.005	Trace	.10	7th foot	
	2158	.005	Trace	.08	8th foot	
	2159	.003	Trace	.106	9th foot	
J. R. Willis, Plains.— S. E. ¼ Sec. 27 T. 20 N. R. 26 W.	2160	.003	Trace	.032	10th foot	
	2161	.004	Trace	.154	1st foot	Gravel 10 to 12 ft.,
	2162	.009	.034	.143		
	2163	.007	.015	.143		
	2164	.003	.011	.138		
C. C. Willis, Plains.— N. W. ¼ Sec. 27 T. 20 N. R. 26 W.	2165	.007	.007	.074	5th foot	Coarse sand.
	2166	.002	Trace	.026		
	2167	.003	Trace	.053		
	2168	.002	.61	.048		
	2169	.005	Trace	.037		
J. Beckstead, Warm Springs,— 25 yds, N. hay corral.	2170	.003	Trace	.053		
	2171	.081	1.047	.17	1st foot	Almost nothing growing.
	2172	.021	.160	.18	2d foot	

75 yds. S. E. corral.	2173	.017	.244	.085	3d foot	Gravel
	2174	.010	.102	.106	1st foot	Fine crop hay.
	2175	.009	.060	.074	2d foot	
	2176	.007	.041	.064	3d foot	
	2177	.006	.041	.064	4th foot	Gravel.
Bitter Root Stock Farm.— sandy, one of the best soils.	2182	.005	Trace	.032		Gravel 1ft., beets 20 tons per a., topped
Hamilton No. 3.	2183	.003	.040	.016		Gravelly soil, 4 tons topped.
Hamilton No. 2.	2184	.004	Trace	.092		Sandy loam, 12 tons.
West side.	2185	.004	.013	.074		Alkali bottom, 15 tons.
Pendergast No. 1.	2186	.126	.459	.085	1st foot	
Pendergast No. 1.	2187	.010	.034	.175	18 in	Gravel.
Gilchrist No. 1.	2188	.010	.020	.133	1st foot	
Gilchrist No. 1.	2189	.012	.029	.122	2d foot	
Gilchrist No. 1.	2190	.010	Trace	.085	3d foot	
Gilchrist No. 1.	2191	.012	.022	.053		
Gilchrist No. 2.	2192	.005	Trace	.042		
Upper Ward No. 1.	2193	.003	.041	.037		General
Upper Ward No. 1.	2194	.003	Trace	.053		High land former orchard 10 to 12 ton.
Upper Ward No. 1.	2195	.005	Trace	.016		Some alkali.
						General sample.
Lower Ward 1.	2196	.003	Trace	.026		Shallow soil 10 in. to gravel, 16 tons
						beets.
Ravalli 1.	2197	.007	.038	.021		Good soil 15 tons.
Rev. Wm. Cobleigh, Corvallis.	2198	.007	Trace	.037	1st foot	
Rev. Wm. Cobleigh, Corvallis.	2199	.007	Trace	.058	2d foot	Gravel.
Corvallis 1.	2200	.003	Trace	.021		Old feed corral, good yield.
Hamilton No. 4.	2201	.003	Trace	.053		Poor beets, very small.
Hamilton No. 1.	2202	.003	Trace	.053		Good beets.

## SOILS FROM EXPERIMENT STATION.

Description	Laboratory Number	Phosphoric acid, per cent	Potash per cent	Sodium Sulphate per cent
Location No. 4, Clover field, 20 acres, S. W. corner of farm, soil 12 in deep, Gravel 4 feet 3 inches.	680	.16	.276	.015
Subsoil of above.	681	.17	.159	.017
Location No. 5. Clover field west of Station building, soil 12 inches deep, heads of clover mostly dead in small patch, rest of plant thrifty. Clover left for seed. 1st foot.	691	.14	.269	.017
Clover left for seed. 2nd foot	683			.08
Clover left for seed 3rd foot.	684			.04
Clover left for seed 4th foot.	685			.023
Location No. 6. Clover N. W. corner of farm, moister than location No. 5. Gravel and water 3 feet.	691	.14	.269	.01
Subsoil of 691	692	.17	.163	.015
Silt from north end of farm on beet plat.	693	.17	.219	.01
Rotation plats. No. 1. Wheat. Gravel 3 feet 9 inches. Soil 12 inches.	694	.18	.300	.013
Rotation plats. No. 2. Peas. Gravel 4 ft. 6 in. Soil 10 inches deep.	695	.17	.284	.006
Rotation plats No. 3. Oats. Gravel 3 ft., 6 in. Soil 9 in. deep.	696	.16	.223	.017

Rotation plats No. 4. Beets. Gravel 3 ft. 9 in. Soil 10 in. deep.	697	.17	.238	.009
Rotation plats No. 5. Barley. Gravel 3 feet 9 inches. Soil 8 inches deep.	698	.157	.206	.005
Rotation plats No. 6. clover. Gravel 4 feet 3 in. Soil 12 in. deep.	699	.15	.211	.01
Subsoil of 694	700	.17		.005
Subsoil of 695.	701	.15	.213	
Subsoil of 696	702	.14	.168	.005
Subsoil of 697	703	.158	.291	.001
Subsoil of 698	704	.16	.165	.009
Subsoil of 699.	705	.16	.180	.021

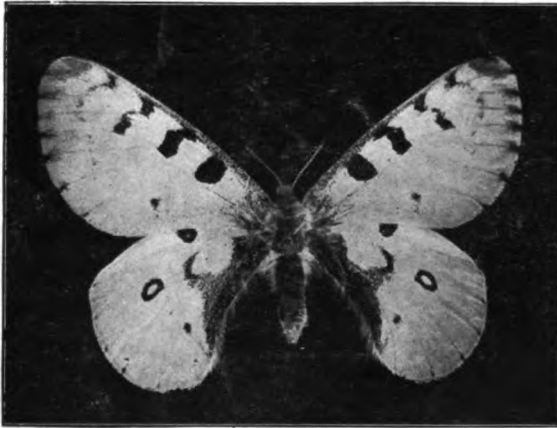
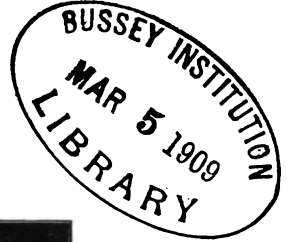


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See 1635.257

**MONTANA AGRICULTURAL COLLEGE  
EXPERIMENT STATION**

F. B. LINFIELD, Director

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BULLETIN NO. 55 L  
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**SECOND ANNUAL REPORT  
OF THE  
STATE ENTOMOLOGIST**

BY  
R. A. COOLEY

\_\_\_\_\_  
BOZEMAN, MONTANA  
DECEMBER, 1904

# MONTANA AGRICULTURAL COLLEGE EXPERIMENT STATION

BOZEMAN, MONTANA

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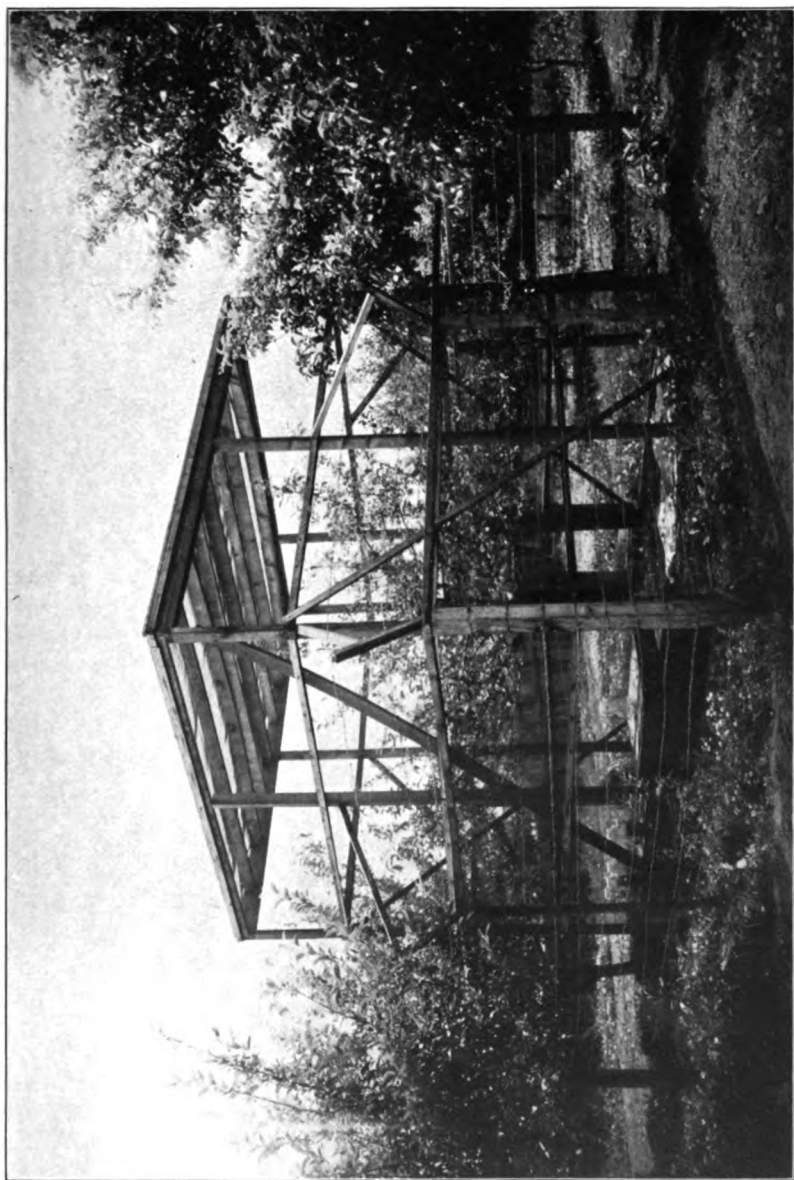
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NOTICE.—The Bulletins of the Experiment Station will be mailed free to any citizen of Montana on request. Please state whether all publications are desired as issued or only those specified. Give name and address plainly.



Cage at Missoula used for the study of the life-histories of the codling moth and the bud moth.  
The cage is 12x12 feet on the ground and 12 feet high.



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## THE ELM MEALY-BUG.

*Phenacoccus dearnessi* King.

While searching for cocoons of the codling moth under scales of bark of apple trees in Missoula in January, 1902, numerous cottony masses were found secreted under the scales and not visible except when the scales are picked off. These cottony masses contained the eggs and adults of a mealy-bug which I have referred to *Phenacoccus dearnessi* King. Specimens were sent to Prof. T. D. A. Cockerell, the American authority on these insects, and he replied that it appeared to be this species and on comparing it with the descriptions his conclusion was found to be correct.

On April 30th in the same vicinity in Missoula, numerous mealy-bugs, which later were found to be the same species, were found closely packed on elm buds which at that date were greatly swollen and about to open. See Fig. 1, 1. During the remainder of the

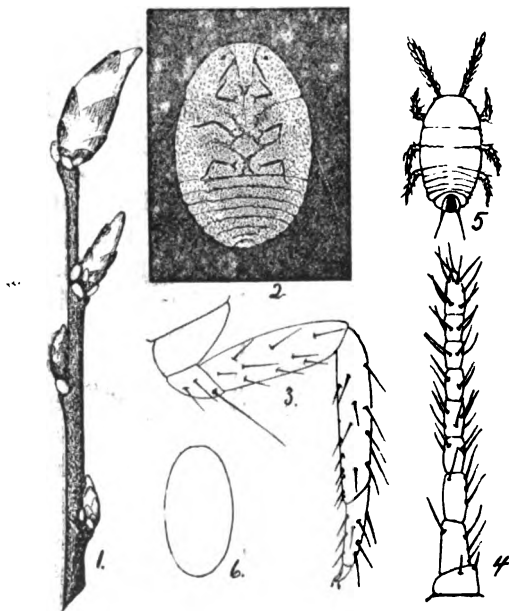


Fig. 1. The Elm Mealy Bug: 1, Mealy bugs at bases of buds of elm in spring of the year, natural size; 2, adult female from below, enlarged; 3, leg of female, enlarged; 4, antenna of female, enlarged; 5, newly hatched larva, enlarged; 6, egg, enlarged.

season of 1902 and in 1903 the species was commonly seen both on the apple and the elm at Missoula.

On making inquiry I learned from Mr. C. F. Dallman, proprietor of the Missoula nursery that this insect has at times been so abundant on the limbs and trunks of elms as to cause the leaves to wither. From the foregoing it appears that while the insect was originally found on the apple at Missoula it is more particularly a pest of the elm and that on that desirable shade tree it is capable of becoming a serious pest. So far as the notes in this office show, we have, beside this mealy-bug, only one serious pest of elms in Montana. This is the aphid which lives on the leaves causing them to curl and become deformed.

### HISTORY OF THE SPECIES.

*Phenacoccus dearnessi* was originally described by Mr. Geo. B. King. Mr. John Dearness collected the original specimens from an old hawthorne tree near London, Ontario. The species has not been heard of since Mr. King's mention of it in Volume 33 of the Canadian Entomologist until this writing.

### A RELATED SPECIES.

This mealy-bug is a member of the family of bugs scientifically known as *Coccidae*. To this family belong the true scale insects, soft scales, cottony cushion scale, the cochineal insect, and the lac insect. Altogether they form a very large and important group, there being upward of one-thousand five hundred species known to science. Another species in the same genus as the one that is the subject of this paper, has been injurious on maples in the eastern part of the United States. This species (*P. acericola* King) has about three broods during the year and does its damage by sucking the juices out of the leaves. The cottony masses on the under side of the leaves are conspicuous objects and where the insects become abundant they cause the leaves to become yellowish and sickly or drop off prematurely. The winter is passed by the young nymphs which secrete themselves in the crevices of the bark and there remain dormant. In the spring becoming active again they crawl to the leaves.

### HABITS OF THE ELM MEALY-BUG.

We have learned but little of the life-history of the species found at Missoula but it is probable that it is similar to that of the maple-inhabiting species. However, it is plain from our observations that at least a part of the insects remain on the trunk of the apple throughout the summer. In fact, though we were often in the orchard in Missoula where this insect occurred in 1902, frequently running across clusters of the insects under the scales of bark, we did not in a single instance find any of them on the leaves. Occasionally we found the partly grown female insects crawling about the limbs and twigs but never attached and feeding except on the trunk. Under the scales of bark the insects were invariably found under the newly formed scales where the bark was of a light color and thin.

The habit of the females in the spring of the year to cluster about the buds of the elm as shown in the accompanying figure, is a prominent one though we did not detect any injury done in this way. As the female insect feeds and grows she produces a very light and soft cottony mass about herself which is pure white. On coming to maturity the insect deposits her eggs in this cottony mass. When the young hatch from the eggs they work their way to the surface and go off to find a suitable place to secure food.

### CONFUSED WITH THE WOOLLY APHIS.

It is a well known habit of the areal form of the woolly aphis to settle on newly made scars on the trunks of apple trees taking their nourishment through the tender tissues to be found there. This mealy-bug was found affecting apple trees in the same manner. So similar are the cottony masses of the two insects that the writer was able to be sure of the identity of the mealy-bug only by breaking apart the flocculent matter and examining the bodies themselves.

### DESCRIPTIONS.

The male and female mealy-bug are very unlike in appearance. The male is very delicate and has long transparent wings, long legs, and long antennae. Its size is much less than that of the female which is about  $\frac{1}{8}$  of an inch long. With all secretions removed

the body of the female is yellowish in color. The legs and antennae are short and there are no wings. The female walks very slowly.

A technical description of the species is not given here but may be found on page 180, of Vol. XXXIII, Canadian Entomologist. 1901.

### REMEDIES.

This pest may be controlled by the use of soap or kerosene washes applied to the trunks of the trees during the winter season. Its complete destruction will be facilitated by scraping off the loose outer bark before applying the wash. Kerosene emulsion and soap washes have been discussed in previous publications of this department of the Experiment Station.

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## THE STRAWBERRY CROWN-GIRDLER.

*Otiorhynchus ovatus* Linn.

The strawberry crown girdler was brought to the writer's attention as a pest in Montana in the summer of 1899 and since that time has been the subject of much interest in this office. The economic and biological features have been closely studied, but while we now make a report, it is not because we have learned all that we might on these subjects. More work might be done on the evasive problems connected with the life-history and methods of controlling the insect, but having reached a point where recommendations suggest themselves, it seems desirable to publish what information we have secured. We shall at the same time review the work of previous writers.

During the summer of 1902 observations of considerable value were made on the natural history of the species both in the field and in the laboratory, and again in 1903 facts of some value were secured. During the past summer (1904) Mr. Burle J. Jones, a graduate of the Montana Agricultural College and a thorough student of entomology, was stationed by this office at Missoula for the purpose of collecting insects and observing the habits of certain pests. He was informed of the status of our knowledge of this insect and instructed to closely observe its habits in order to verify our previous notes and if possible to secure new facts. Because of the fact that we were unable to have Mr. Jones in the field early in

the season and to keep him there until the close of the season, we did not have an opportunity to determine the number of broods of the beetle nor the stage in which most of the insects pass the winter. Mr. Jones made the observations on the effects of spraying with, and dipping in, arsenate of lead, and very carefully studied the habits of the insects during the three and a half months of his stay at Missoula.

### GEOGRAPHICAL DISTRIBUTION.

The strawberry crown girdler is an introduced species, having come to this continent in all probability from Europe. It is known to occur in Europe and Siberia. In the United States it has been found from the Atlantic coast west to the state of Washington. The most southerly points at which it has been recorded are Alleghany, Pa., and Santa Fe, New Mexico. Both of these points are just within the southern boundary of the transitional life-zone and it is probable that this beetle finds its southern limit at about the line between the transitional and upper austral life-zones.

From the list of places given below, where the beetle has been recorded, it will be seen that though of foreign origin, this insect has become widely and generally distributed. Being entirely without wings it is dependent upon outside agencies for transportation except over such short distances as it can cover by walking. More will be said about the means of distribution in a later paragraph.

The following is a list of the records of the distribution of the strawberry crown-girdler.

Massachusetts, 1852, Henshaw. Cambridge, Mass., 1865, Henshaw. Cambridge, Mass., 1874, Henshaw. Wyoming, Mass., 1874, Henshaw. Alleghany, Pa., 1875, Wickham. Detroit, Mich., 1878, Wickham. Hanover, N. H., 1880, Henshaw. Buffalo, N. Y. 1882 (?) Wickham. New York, 1884, Lintner. "Southern Michigan," about 1882 or 1883, Weed. Ottawa, Canada, 1884, Harrington. Iowa City, Iowa, "not later than 1886," Wickham. Nova Scotia, 1889. Chicago, Ill., 1889 Wayne Co., Ohio, 1892. Quebec, Canada, 1892. Indiana, 1892. New Jersey. Laramie, Wyoming, 1893, Wickham. Santa Fe, New Mexico, 1894, Wickham. Minnesota, 1895, Lugg. Missoula, 1897, Wilcox. Bozeman, Montana, 1899, Cooley. Helena, Montana, 1904, Cooley. Lake Washington, Wash., 1904, Melander (in Lit.)

### COMMON NAMES.

This insect has been known in Mont. under the name of strawberry-weevil, but since there are a number of other weevils that prey upon the strawberry, it would be advisable to use the more specific name first adopted by Prof. Weed, viz.: "The Strawberry Crown Girdler." In a reference in *Insect Life* (Vol. V, page 46) it is stated that in some localities the insect is known as the "graveyard bug." Professor Wickham, writing in *Societas Entomologica* (IX, page 131, 1894), states that Dr. Hamilton writing to him from Alleghany, Pa., stated: "I took this beetle in a cemetery here in 1875 and it was then apparently abundant. A couple of years afterwards it was excessively so in the same cemetery but now (1894) much less common than formerly." It may be that the beetle contracted the name of "graveyard bug" from its occurrence in the cemeteries of Alleghany as here quoted, but the literature does not make this point clear. There can be no reason why the insect should occur more abundantly in graveyards than elsewhere. Dr. Lugger in his short account of the beetle in Bulletin 66 of the Minnesota Experiment Station (1899) uses the common name, "The Pitchy-Legged Otiorhynchus." This name is obviously less desirable than "The Strawberry Crown Girdler."

### FOOD PLANTS.

The following is a list of the plants on which this beetle feeds as shown by the literature of the species: borage (Cook), muskmellon (Webster), strawberry (Weed), currant (Mrs. Wickham), roots of blue grass (Webster), apple (?) (Lugger). The writer has found the larvae feeding on the roots of *Potentilla glandulosa*, a plant not distantly related to the strawberry, and has found the beetles hiding in abundance in the stools of this plant. The species was also taken feeding in the adult stage on the foliage of raspberry. Mr. Burle Jones found the roots of the plant commonly known as the "big root" or "balsam root" (*Balsamorhiza sagitata*) to be commonly attacked. He found fully one hundred weevils about one plant of this species and saw abundant signs of their attacks in other plants of this kind. Mrs. Williams of Missoula reports having found the larvae in great abundance on the roots of timothy grass.

As affecting the methods of controlling the ravages of this pest a knowledge of the food plants it is of great importance. More will be said on the subject under the head of remedies.

Only scattered observations on the feeding habits have been made as recorded above, but various writers have suggested that it is probable that the species feeds on a large variety of plants. Our observations bear out this belief. The food plants above recorded are widely scattered through the vegetable kingdom and it would not be surprising to find in a complete list, if such a list could be obtained, a very large number of widely differing plants.

Further observations on the feeding habits of this beetle in different parts of the United States are very desirable and might prove to be of great value.

### INJURIOUSNESS.

In only two localities in this state has this pest become noticeably destructive, so far as we are informed. These two places are in Missoula Co., one being on the farm of Mr. Chas. Williams in the Rattlesnake Valley north of Missoula, and the other at the place of Mr. England west of the city. At Mr. England's place the beetles were very injurious about five years ago and drove him out of the business. He gave up attempting to grow strawberries for a period of four years, and then Mrs. England in the spring of 1904 set out a new bed not far from the old patch. So far as the experience of 1904 shows, no beetles are on the place. An explanation of this present freedom from the pest offers itself and is discussed under the head of remedies.

At the Williams place the beetles have prevented the profitable growing of strawberries for about eight or ten years. Great credit is due to these people for the persistence with which they have tried to overcome the pest. They have studied its habits both out of doors and in cages in the house and are remarkably familiar with its haunts and ways. They have moved their strawberry beds from one place to another all over their large and beautiful ranch and have invariably confronted the pest in each new spot. They have tried every means of control within their reach and have showed much ingenuity in their campaign but always at the time when the berries should be growing and coming to maturity, the vines gradually

weakened, because of the grubs at the root, and they harvested very poor crops. The beetle has shown itself capable of wiping out the strawberry industry in the territory in which it operates. Up to this time we have been powerless to check its ravages.

Fortunately it spreads very slowly or else is closely confined to certain soil conditions. It has been a matter of much interest to us that on the farm adjoining that of Mr. Williams, just across the road and an irrigating ditch, strawberries have been grown very successfully. On one occasion I entered this field and found very luxurious foliage and saw the pickers harvesting a full crop of berries, while at the Williams place the crop was destroyed. After five years' experience with the insect we feel warranted in saying that it is probable that it is quite definitely confined in restricted localities and that excessive injury will result only when it is attempted to grow strawberries in these localities. In driving up the Bitter Root valley in the summer of 1902, I stopped by the road and collected insects. It developed that I was in the midst of a colony of this beetle. Masses of their dead bodies were to be found under pieces of bark on the ground. So far as I was able to learn no one has ever grown strawberries within several miles of this spot. The limits of this colony were not far off and beyond the limits no beetles were found. The fact that the species is gregarious in habits may in part, but does not fully, explain this marked tendency to live in limited areas. Further, it may be said that the presence of the beetle in a strawberry field in small numbers is not necessarily an indication that it will increase and become injurious. Though we have found the beetle in garden patches of strawberries in the city of Missoula we have never had a complaint from that city.

It is not a usual practice to continue to grow strawberries on one piece of ground year after year, and though a few specimens may be brought into a bed it is not probable that they will multiply with sufficient rapidity to become seriously injurious before the bed is abandoned. We believe that serious injury will be done only where strawberry beds are planted on fields where the beetles are already present in abundance. Literature shows no record of extensive injuries from this insect though its possibilities as a pest have been mentioned.

## INJURIES TO PLANTS OTHER THAN THE STRAWBERRY.

It should be borne in mind that this beetle, being a very general feeder, may develop into a pest of various other plants. As we have mentioned under our discussion of food plants the larvae are said to feed voraciously on the roots of timothy grass. We may therefore expect it to be very injurious to crops of timothy that are planted in territory which it has invaded. There is nothing to assure us that it will not seriously injure various other crops.

### NATURE OF ATTACK.

The adult beetles feed on the foliage of the strawberry and the larvae feed on the roots. In an old bed one or more years of age, the injury done to the foliage does not appear to be serious but on newly set plants in the spring or early summer, the beetles come in such numbers, eating the foliage and boring holes in the stems, as to destroy the bed before it gets a fair start. The experience of Mr. Williams has been that during the first summer when the plants were small and just getting started, here and there a plant would be killed. The next summer more would die and in the third summer, at the time fruit is growing, many plants would die owing to the large number of grubs at the roots. At the time the full crop should be expected the bed may be so invaded that not more than one plant in ten to twenty of those that were set out is left.

The beetles eat irregular patches out of the leaves as shown in plate II, fig. 2. This is a newly set plant photographed in the field. It is not uncommon to find from fifteen to thirty beetles hiding about a single young plant.

The larvae feed on the roots and kill the plants outright. A plant that is dead or nearly dead from this cause has many of its larger roots eaten off and is more easily removed from the earth than a healthy one. The younger larvae appear to feed on the fine rootlets some distance away from the crown of the plant, and as they grow older they work their way up the roots, many of them eventually reaching the crown or dense masses of roots just beneath the crown. I have never found a larva of this species really imbedded in the crown. They seem to prefer the more exterior parts just where the roots arise. Where they feed, a powdery brown substance, their castings, is to be seen. They also feed from the surface of the lower part of the crown more or less completely girdling the plant.

## DESCRIPTIONS AND NATURAL HISTORY.

The general appearance of the adult beetle is well shown in the accompanying photographs, (see Plate I, figs. 1 and 2). These photographs are greatly enlarged but the beetle is also shown in natural size above and to the right of figure 1. When first emerged the beetles are light brown in color but they soon take on a permanent brownish black. The antennae are elbowed and are slightly enlarged at the very tip. The shell of the beetle is very hard.

Most beetles have a pair of wings folded beneath the hard horny wingcovers that overlie the abdomen or posterior part of the body, but in the case of the beetle in question no wings are present and the wing-covers are grown together in such a way that they could not be raised as in flight if the wings were present. The beetle therefore is as incapable of flight as a toad and for locomotion is dependent on walking or on outside agencies.

The adults are nocturnal in habits and gregarious. When disturbed they draw in their legs and play 'possum.

On examining the earth around strawberry plants affected with the adult beetles one finds small open holes that lead into the earth toward the roots. Carefully following these holes with a straw or the point of a knife blade the beetles may be found often in considerable numbers. These holes often follow the stems of leaves of plants that are newly set, being often just under and parallel with the stems. Other holes follow down under small clods of soil or other objects. Other beetles may be found under partly covered leaves and many may be found scattered through the soil about the roots. Among old plants they often crawl down into the crown where the new and old leaf-stems arise. In all such places they spend the day, coming out to feed during the night.

It appears that the beetles are more or less dependent upon food in order that they may develop ova. Our investigations have shown plainly that the beetles crawl about in the soil for the purpose of scattering their eggs. On our potted plants used for studying the beetles we found some eggs on the surface of the soil and a few even on the under surface of the leaves, but we believe that the normal place for egg deposition is in the soil. The soil in the pots was harder than is natural for out-of-door conditions and some of the

leaves were close to the earth. Many of the eggs in the pot experiment were found to be in the burrows and in the little cavities used by the beetles as retreats from the light. This habit of the beetle of scattering the eggs among the roots is perhaps nature's method of making sure that the very small weak larvae shall not fail to secure food, for it is very doubtful if the newly hatched young could make their way through the soil to the roots.

The habit of congregating in large numbers in darkened places is a marked one with this beetle and large numbers have often been found in houses under carpets and in similar places. Mrs. Williams' house was invaded by them and this peculiarity has been more often mentioned in literature than any other.

The gregarious habit is also shown when the beetles go into hibernation, for in the spring of the year under clods of earth, under stones, boards, etc. the beetles may be found in great abundance.

#### THE EGG STAGE.

The eggs of this beetle are very minute objects measuring only about .25 mm. long. The general shape and appearance are well shown at figure 4, plate I. When first laid the eggs are milky white but a little later they take on a pale brownish color.

We can closely judge of the duration of the egg stage from the following experiment. On May 31st, 1902 I brought living beetles from Missoula to Bozeman and on June 2nd ten beetles each were put on five strawberry plants in pots at the Experiment Station. On June 7th a few eggs were found. The eggs became more and more abundant and on the 21st there were many eggs to be found. The soil was not examined again until June 27th when a few young larvae were to be found. It thus appears that about twenty days or a little less are required for the eggs to hatch.

On June 27th the eggs were very abundant and it was roughly estimated that there were 200 eggs in one can. It was impossible to accurately count them. It will be remembered that ten beetles were placed on each plant and if one-half of these were males, the five females laid at the rate of forty eggs apiece. In making the examination, so much of the soil was removed from the roots of the plants that the plant which had already been weakened by the attacks of the beetles could not be kept alive longer; otherwise it is probable that more eggs would have been deposited.

## THE LARVA.

The newly hatched larva resembles the older larva in shape and color but is much smaller, being almost microscopic in size. They feed on the fine rootlets and in a soft soil are perfectly at home, getting about slowly but with ease.

The older larva is a conspicuous object against a back ground of dark soil being itself almost white in color with a yellowish head. See figure 6, plate I and figure 1, plate II.

We have nothing to indicate to us definitely the duration of the larval stage.

## THE PUPA.

When full-fed and ready to pupate, the larva constructs an oblong cell in the soil and casting its skin becomes a pupa. See plate I, figure 5. In this cell the helpless pupa remains until the adult stage is reached.

The pupa is almost pure white, very soft and delicate, and shows distinctly the various parts which in adult life will be known as legs, antennae, beak, wings, etc. It is noticeable that the wing-sacs are separate along the line of the back, while in transforming to the adult stage they become fused forming one piece.

## NUMBER OF BROODS AND HIBERNATION.

We can state definitely that the winter is passed both in the adult stage and as larvae. It may be also that some individuals pass the winter as pupae. As early as August the beetles begin to show a tendency to come together to go into hibernation quarters and yet in the fall and spring larvae may be found in the soil. The different stages so overlap each other that one can find eggs, larvae, pupae and adults all at the same time and this condition leads to much confusion in an attempt to determine the number of broods. We can give but little evidence as to the number though we hold the opinion that there is but one brood each year.

### MEANS BY WHICH THE CROWN GIRDLER SPREADS.

It is a remarkable fact that though this insect possesses no wings and cannot fly, it is capable of widely distributing itself as is shown by the records of its occurrence. It is a slow walker, practically speaking, and is dependent upon outside means for its distribution. Very likely it has been distributed to some extent on strawberry plants sent for planting new fields. Its desire to avoid light would naturally lead it to retreat not only into houses, as has been recorded, but also into barns and other buildings as well as boxes, farm machinery, and any other objects whatsoever that offer desirable places of retreat. In any such objects that become articles of commerce or are removed from one place to another for any purpose, such as household goods, etc. carried by persons moving from one place to another, the beetles are liable to be taken into a new locality, and once in the new locality, being adapted to a large number of wild-growing and cultivated plants, they stand a fair chance of becoming established.

### NATURAL ENEMIES.

We have observed no parasitic enemies of this beetle and Professor Weed bred none though he confined many of the insects for the purpose. Mrs. Williams reported to me that the domestic fowls followed the plough in the spring ravenously eating the early stages, which because of their white color, were conspicuous objects. Mr. Weed reported that he found the predaceous larvae of *Carabid* or ground beetles in the earth around the roots of strawberries that were attacked by the girdler larvae.

### REMEDIES.

The two general methods of restraining this pest that suggest themselves are the use of a poisonous spray and the use of such cultural practices as interrupt the life cycle of the beetle.

Mrs. Williams informed me that she had made a thorough test of the use of Paris green as a means of poisoning the adults on the foliage and had not been able to kill them. Knowing the general characteristics of the beetles we were not surprised at the results secured in the test and decided not to make any further tests with Paris green.

**EXPLANATION OF PLATES.**

Photographed from nature from specimens secured at Missoula, Montana. The natural size of the various stages is shown in small circles, except in the case of the egg which is almost microscopic in size.

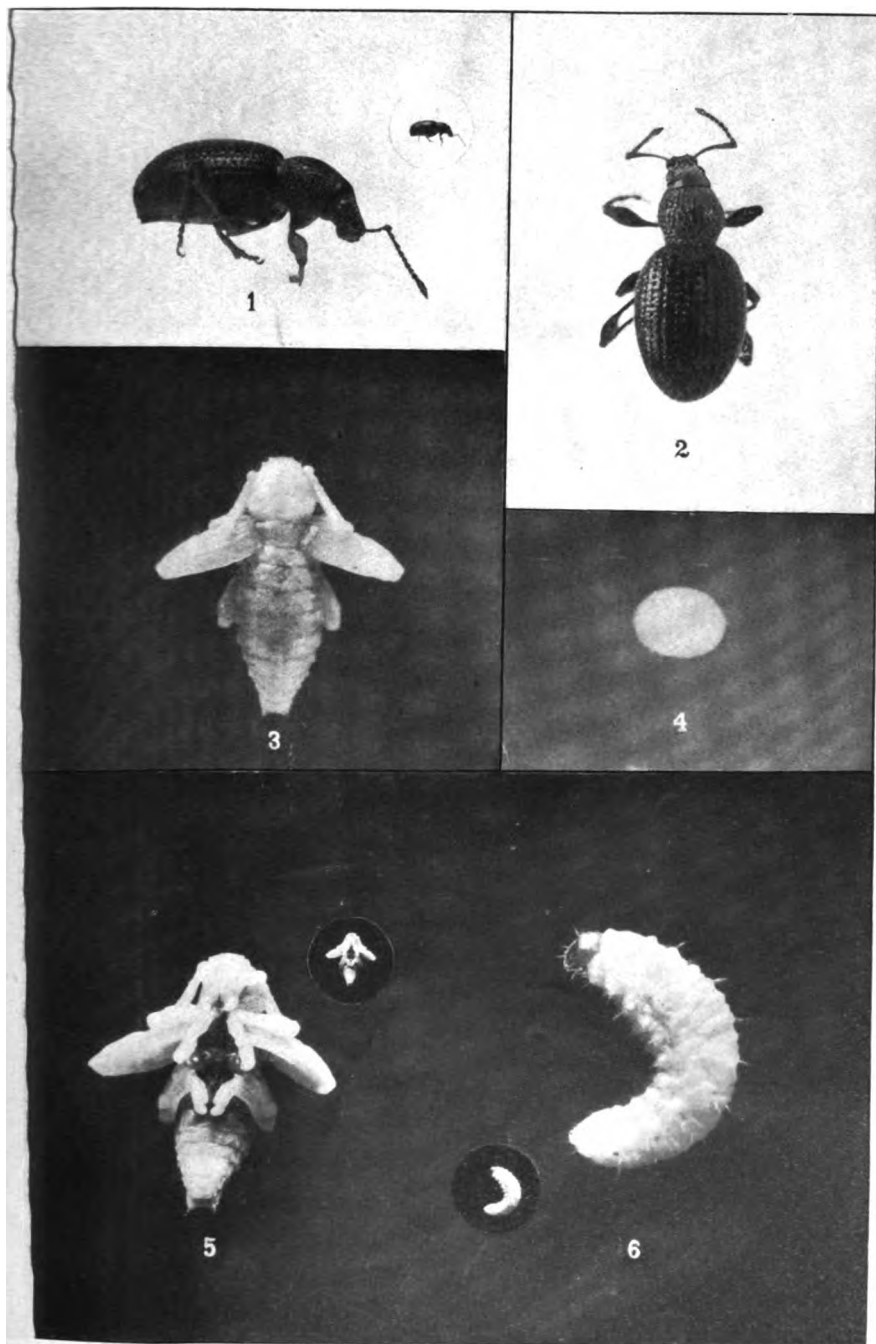
**PLATE I.**

- Figure 1. The adult beetle from the side.
- Figure 2. Top view of the adult beetle.
- Figure 3. Top view of the pupa.
- Figure 4. The egg greatly enlarged.
- Figure 5. Ventral view of the pupa.
- Figure 6. The larva.

**PLATE II.**

- Figure 1. Larvae taken from the roots of one strawberry.
- Figure 2. Strawberry plant showing foliage eaten by the larva of the strawberry crown girdler.

PLATE I.





## DIPPING IN ARSENATE OF LEAD.

At the writer's suggestion arsenate of lead, secured from the Bowker Insecticide Company, was used. This substance has certain marked advantages over Paris green as an arsenical insecticide for use on the foliage of plants. Being insoluble in water it may be applied to tender leaves in much greater strength than is safe with Paris green. And there are very few insects, if any, that cannot be killed by it or driven from the plants sprayed with it. Moreover, it remains on the foliage much more persistently than does Paris green, and hence is very desirable in a climate with frequent rains that would easily wash off an application of Paris green.

We suggested to Mrs. Williams that she try dipping her plants in the substance before planting them in the field and then follow up this treatment with later sprays as new foliage appeared. It was felt that if the beetles could be driven off from the new plants the bed would be free ever afterward.

Mr. Jones watched this test and reported that dipped plants were entirely immune for about two weeks after setting and after that length of time the beetles gradually appeared and fed on the new growth that was being put forth. The foliage was then sprayed and the plants were again immune, but it was noticed that the plants were not doing well and it was found that the ingenious beetles were feeding on the roots! It will be remembered that it is the habit of these beetles to hide among the roots in the soft soil and it is not surprising, that impelled by hunger, they fell to feeding on the roots. Beside finding the roots of the plants gnawed, Mr. Jones took the trouble to make a microscopic examination of the contents of the intestine and concluded that it was composed of what had been eaten from the roots of the strawberry. The practical conclusion drawn from this test is that, while the use of arsenate of lead in the manner indicated cannot be relied upon to keep the bed free from the beetle, the treatment is probably very much better than nothing. Dipping the plants before setting them is easily done and the cost and trouble of spraying two or three times with arsenate of lead at the rate of five pounds to fifty gallons of water is not great.

The one result of our investigations that appears to be of greatest practical significance is the discovery of the fact that the trouble from the pest arises from the presence of great numbers of the

beetles, and their larvae, in the earth, living on natural food-plants at the time the soil is broken up for the planting in strawberries. Therefore the remedial measure that seems to promise most is so managing the soil that when it is desired to set out the field to strawberries the beetles will have been previously starved out; in other words the use of a cultural method. We have not had opportunity to make a practical test of this promising method but we are reminded in this connection that Mr. England, who lives just west of Missoula, some years ago was so troubled with this insect that he abandoned strawberry growing entirely, using the land for other crops. Mrs. England started in again to grow some plants, in a small way in the summer of 1904, and had no trouble whatever with the insects.

Mr. Williams' trouble has been principally on newly broken, virgin soil and we feel that if he had allowed the soil to lie fallow for one season, keeping it free from vegetation, he would have been troubled only in so far as the beetles are able to migrate into the field from the sides.

While the beetles are very general feeders, it is probable that there are crops that could be tilled that would be let alone by them and it is desirable to try planting potatoes and some other common crops, making critical examinations of the roots from time to time to learn if they are eaten by the larvae. If potatoes or any other crop is found to be immune, it may be used on virgin soil infected with this beetle and followed the next season by strawberries.

## NOTES ON THE BUD MOTH.

By B. J. JONES.<sup>1</sup>

This insect was discussed at considerable length in the Entomologist's Report for 1903. Conditions were found to be so favorable in the cage at Missoula, however, that it was thought best to make a further critical study of it there during the summer of 1904. As the work began May 12th and ended August 22nd this study of course did not deal with the first spring activities or with the winter hibernation of the pest. The present publication may be regarded as dealing with the seasonal dates and peculiarities of its transformation, and establishes, as we believe very conclusively, a number of points in the life-history which differ considerably, in this state at least, from the ordinary routine as worked out and published in the very excellent works of Professor Slingerland and others. As these differences have much to do with the possible effectiveness of insecticides they will be given special prominence in the present discussion, while other points already established will not be considered.

It was estimated that fully two-thirds of the flower buds on the tree in the cage, from which all of the observations were taken had been destroyed by the young larvae. Under date of May 12th it was recorded that, though varying somewhat in size, the larvae measured almost uniformly one-fourth inch in length. They were rolled tightly in dead leaves, were practically inactive during the day, and seemed quite invulnerable to any possible application of spray. They were quite dark in color and apparently ready for the first spring molt. Two days later this theory was verified, for a number of larger, fresh larvae were found in the early morning migrating from the former hibernacula and establishing themselves upon new and larger leaves. The migration soon became general and a large per cent of the worms were found to move to other quarters where they were for some time uncovered and susceptible to spray

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1. The work on the bud moth at Missoula in the summer of 1904 was conducted by Mr. Burle J. Jones, a graduate from the Montana Agricultural College in the class of 1904. The outline of the work that we desired done was given him and the special problems indicated. Mr. Jones is a conscientious observer and promising student of economic entomology.

while constructing the new retreats. In building its cocoon the larva usually selected a position along the mid-rib of the leaf and began to weave a silken web back and forth, using mouth and feet. After a considerable net-work had been spun this operation was suspended and the worm proceeded to tap the mid-rib near the petiole, or the petiole itself, in such a way as to cut off the food supply. The elastic threads draw the edges of the leaf together as it wilts and, aided by the larva within, soon it is doubled, forming a secure hiding place. As the leaf withers and droops it naturally touches others of the cluster and is skilfully attached to them by its busy inhabitant. This serves a double purpose since it prevents the withered leaf from dropping and provides a very convenient feeding ground for the worm. The hibernaculum is continually enlarged and strengthened with silk, frass and scraps of leaves. In a few days it became evident that the larvae must emerge from these withered leaves in order to obtain food. This indeed was found to be the case, and each morning showed signs of renewed attacks upon the surrounding foliage. In the early morning, especially on dark, cloudy days, a large percent of them were actively engaged in these exposed places, retiring to the nest in the bright hours of the day. As a rule these feeding grounds were entirely free from the nest and upon exposed surfaces of the leaves since the larvae in this stage do not feed upon the epidermis of the under side. This propensity to migrate to new quarters did not seem to be due to the fact that the tree was so badly infested, as might be expected, for even in this case there was seldom more than a single worm in the cluster of leaves from one twig. It was rather due to the fact that the former quarters were not only unfit for the growing worm but were also usually a considerable distance, comparatively, from desirable food. In a few cases the larvae remained in the original hibernacula, but a careful estimate showed that about 75 per cent of them did actually migrate and establish new homes. The general trend of the moving was from the center of the bole and larger limbs where the winter cocoons were spun toward the outer and younger growth.

At no time during its larval stage does the insect eat as voraciously and grow as rapidly as during this interval between the first and second spring molts, so that a considerable surface is actually repre-

sented by the feeding grounds; the caterpillars often continue their activity until the morning is well advanced. They attain to a length of between 8 and 10 mm. before retiring for the second shedding of the skin. It became evident then that this period would be especially favorable for the first experiment in spraying. Accordingly, on May 25th a limb of the tree containing 90 hibernacula by actual count was given a thorough coat of Arsenate of Lead in about the proportion of 5 pounds to 50 gallons of water. A tarred band was placed about the base of the limb to prevent migration to other parts of the tree and the ground beneath was covered by a sheet to ascertain whether or not the worms would drop to the ground, either as a means of escape or when overcome by the poison. After about two days it was evident that they were not pursuing their usual habits. Late in the day there were a number moving about on the leaves as though still in search of desirable food; many of these were on the under side of the leaves which were not so heavily coated with poison. They did not feed here, however, and even the customary haunts did not show signs of having been visited. The worms did not grow and soon began to show the effects of their abstinence; some very evidently died of poison and others shrivelled and died in the cocoons. About a fourth of the cocoons were empty and a small per cent of the larvae were found to drop to the sheet, these however were entirely those suffering from poison so that they were unable to attach their threads to the leaves.

Many ants, beetles and spiders were running about over the sheet and some were even seen carrying larvae away. An estimate of 75 per cent was recorded in the notes for the insects destroyed by this spraying, and there was no appreciable damage done to the foliage by the insects after it was applied. A final examination was made after pupation had begun and it was found that only a single worm had attained to the pupa stage.

Pupation began June 7th and by the 10th about a third of the insects were in this stage. It was often undertaken in the last hibernacula but it was especially noticeable that as many as half of the worms constructed new cocoons. These were almost entirely the product of the spinnerets, were constructed in the same way and attached in the same places as the winter hibernacula. Often the old winter quarters themselves were reconstructed and utilized for

this purpose. Though the larvae had maintained a comparative uniformity of size, the pupation lasted over a month and it was August 1st before the last belated pupa emerged as an adult moth. Branches were clipped from the tree and kept in water under small globe cages where the length of the stage was carefully recorded from the first morning after pupation until the emergence of the moth. A number of careful estimates were also made in numbered localities in the limbs. Of six successfully reared in the cans the length of the stage was as follows: 10, 13, 15, 16, 17 and 18 days, giving an average of 14 and five-sixths. Those followed in the tree gave practically the same results. This would seem to be accurate since it was June 25th before there was a general emergence of moths. On July 2nd the first eggs appeared in considerable numbers. The females did not seem to be as careful in selecting places for the deposition of the eggs as those of the codling moth, which had also laid in abundance both in and about the cage. Those of the bud moth were laid irregularly over the upper and lower surface of the leaves, the latter being considerably in the minority although still quite prominent. The eggs when immediately compared with those of the codling moth are seen to be considerably smaller, but under ordinary magnification there seems to be no definite difference in the markings. Contrary to the previous records in this State the eggs were found to be occasionally laid in clusters of from 3 to 8, sometimes slightly overlapping. This might have been due to the fact that the tree was so badly infested, though it was recorded in more eastern localities as being the ordinary method of laying. The preference of the moth for the upper side of the leaves seems to lie in the fact that it is not pubescent and the egg can be better cemented down to prevent the entrance of air. This is apparently an important item since the egg soon dies if the leaf be removed and wrinkles by wilting, or if the edge of the egg be raised ever so slightly. When laid on the under side the eggs are always carefully cemented to the surface beneath the larger hairs of the leaf. Whether this is done by the parent or is due to the plastic and adhesive properties of the eggs themselves is still, I believe, undetermined. After from 4 to 5 days the eggs turn yellowish like the yolk of a hen's egg and by the sixth day a number of reddish dots appear. A day or two before

hatching the black head and thoracic shield of the larvae show through distinctly. A number of eggs were carefully marked by means of bits of paper, string etc. and a weighted average of 11 days was obtained as the length of this stage. In laying the eggs the moths avoided almost entirely the branch of the tree sprayed on May 25th which still retained a considerable coating of the poison.

The first of the larvae began to appear on June 11 and by the 20th the insect was practically again in this stage. When free from the egg the minute larvae proceed at once to the under side of the leaves and begin to feed along the mid-rib or some of its larger branches. Usually they burrow down between the upper and lower skins of the leaf feeding and at the same time covering themselves over with frass and the pubescence of the leaves, which they weave into a solid mass by the use of their spinnerets and ever ready supply of silk. At no time in its existence as a larva is the insect without this string of silk, and wherever it is the end of this life line is always anchored securely. They have been seen to drop a distance of 3 or 4 feet before being stopped by this minute thread, and after waiting a moment for the intruder to leave wriggle back by a whirling motion to the place of attachment. With the younger lighter larvae this is a simple task but the heavy-bodied adult often breaks its life line and drops. When affected by poison the worm often neglects, or is unable to attach its thread and while throwing itself about blindly will often fall to the ground. At first the miniature grub feeds very slowly and it is some time before the feeding grounds are enlarged to any considerable extent. During this time the larvae are so closely covered by their cocoons and hidden behind the leaf veins that they are practically immune from spray of any kind. After about 14 days however they begin again to have a definite routine, making nightly rounds from their cocoons to the more distant parts of the leaves. As they grow and extend their ravages they are of course more unprotected and feed upon a greater per cent of the exposed cuticle. At about this time the grubs apparently foresee a need of extra supplies and as their habitats wither they begin to stick other leaves to them. This is done very skillfully and cleverly; the flat surfaces of the leaves are fastened together and the worms feed within, free from any possible invader. At the first indications of this propensity it was seen that the leaves

must be coated with poison before they were fastened together and on July 15th, before a large per cent of the worms had begun to fasten the leaves together, a part of the tree was given a thorough spraying of arsenate of lead in nearly twice as strong a solution as that formerly applied. Special attention was given to coating the under side of the leaves.

It was naturally some time before the effect of this spraying became evident, since it was not until about July 30th that the process of fastening leaves together in the construction of the so-called houses, which has been so thoroughly discussed in previous publications, began to come into prominence on other parts of the tree. It was now noticeable that these transformations were not going on in the sprayed limbs. A careful examination of the larvae here showed that while they were largely still active, between 5 and 10 per cent only being found dead, yet their ravages had been confined almost entirely to the leaves upon which they had hatched, and that even here the feeding was far down under the coating of poison and not extended as in other parts of the tree. On August 6th the per cent of dead larvae on the sprayed limbs had increased considerably and there was very little noticeable extending of the feeding grounds. By August 18th the condition was still more aggravated, and when on the 22nd a final examination was made the effect of the poison was very evident. On unsprayed parts of the tree the leaves were largely turning brown as a result of the ravages of the worm and the "Houses" consisted of from 2 to 5 leaves. The sprayed parts were practically free from clusters of leaves fastened together, and the foliage was still fresh and green. Though a small per cent of the worms were still alive they were not developing as rapidly as the others and, judging from the observations taken at the first spraying, would never live to go into winter quarters.

The summer was unusually dry and only two heavy rains had taken place since the first spraying on May 25th. That limb was now, on August 22nd, by far the freshest on the tree and most free from attack, and still retained a considerable film of the Arsenate of Lead.

While the experiments given above were limited in their application they certainly show that the range of control of this pest is much wider than was formerly supposed. The fact that the larva

feeds entirely on the leaves after its first spring attack on the opening buds, makes its control a much more tangible problem than that of the codling moth, where the surface feeding is confined to the single hole which it makes in the fruit;; and the fact that the bud moth is actually without covering during a part of the larva stage and feeds upon exposed surfaces, makes the problem still more simple. This does not mean that the insect does not require the most rigid and persistent treatment, nor is it intended to indicate that it will fall an easy prey to an ill-timed and carelessly applied application of poison.

### WHEN TO SPRAY.

Certainly the best time for the first application is in the spring before the flower buds begin to open. The cocoons of the insect should be closely watched and the spray applied as soon as there are signs of activity, or even before if the area to be covered is large enough to consume a considerable length of time, since it is fatal to allow the worms to enter the young buds. The larvae are already advanced in size and have only to proceed to the opening flowers of the nearest twigs, which, by a remarkable instinct of the worms when hibernating in the fall, are usually upon those at the base of which their cocoons are securely fastened, in order to do immediate damage. It is this stage that the orchardist should be especially anxious to control since it is at this time that the damage is done and when the insects are allowed to get well within the opening flowers they are practically safe until the apple crop has been "Nipped in the bud." At this time, however, they are feeling the effects of a long winter's fast and will be very susceptible to the poison if it be very completely and thoroughly spread. But the applications should not end with this, and if there are worms still to be found on the tree, and a few are certain to survive even the most rigid treatment, their habits should be closely watched and as soon as they begin to feed in exposed places they should be again treated to spray. This application should be made at the time that the larvae complete the first spring molt and begin to seek new and larger quarters, such a stage as that described above which occurred about May 25th at Missoula. Even after the summer brood emerges from the eggs the prudent orchardist will find it to his advantage

to pursue them with the ever ready spray pump and nozzle, before they begin to fasten the leaves together. The disadvantages of spraying at this time are: that it is rather difficult to get a thorough coat of poison on the under side of the leaves where the worms are now feeding, that the pubescence of the under side prevents the spray from adhering as closely and uniformly as above, and finally that the fruit, where the trees are bearing, is now ripening in many cases and there is more or less danger of having a coat of poison upon it when it is ready for market; the application can be timed, however, in most cases so as to avoid this trouble. A coat applied when the eggs were still unhatched would cleave sufficiently to make life very uncertain for the resulting larvae. The advantages of spraying at this time are: that the leaf buds have ceased to grow and the spray is good as long as it retains its poisonous properties, since there is no danger of the trees outgrowing it and making fresh feeding grounds for the worms as is the case with the earlier applications. In this advanced stage the foliage is also very resistant and the mixture can be applied at a greater strength than formerly, which up to a certain limit, makes it much more adhesive. As a general rule where trees are infested by this insect keep the the early buds and blossoms sprayed by all means, whether it requires one, two, or three applications, and spray later if the insect is still present.

### HOW TO SPRAY.

This has been widely discussed in bulletins dealing entirely with the subject of spraying and requires only a word here. As a complete and even distribution of the spray is the principal thing to be attained in dealing with this insect a Vermorel, or similar nozzle that will give a wide and fine distribution to the liquid, should be used. In putting on the first spray the operator should not confine his attention to the buds alone but should give the leaves a thorough coating, since the object is not only to keep the insect from doing immediate damage, but to kill it if possible. This of course should be done from an elevated platform, or by means of a long bamboo stick or rod attached to the nozzle so that the topmost branches can be reached and the upper side of the leaves thoroughly covered. In dealing with the summer brood it is

necessary to thrust the apparatus through the limbs in such a way as to coat the under side of the leaves. The operator had best protect himself from drippings by rubber garments or old clothing for which he has no further use. With arsenate of lead it is always necessary to keep the mixture within the pump well churned in order to get an even distribution of the poison, as the heavy lead compound settles rapidly. This is best accomplished by the use of a pump with an agitator provided for that special purpose, but may be done on a small scale by frequently turning the spray back upon itself through the nozzle, or by other methods of churning.

### WHAT TO SPRAY WITH.

As the experiments recorded above dealt only with arsenate of lead we can of course give its relative value with other sprays only by the results obtained from their use in other localities. It is only fair to say in this connection that in the present instance it has given much better results than those recorded from the use of others in other places where it was reported that their effectiveness was not encouraging. It is especially favorable for the first spring application as the young buds at that time are quite delicate and will not always withstand the Paris green compounds, which are likely to burn them at that rainy season of the year. The arsenate can be safely applied at that time in the proportion of four and a half to five pounds in 50 gallons of water; the second dose, if it be applied after the blossoms have gone, may be increased to 5 and a half or six pounds, and the third as much higher as the condition of the fruit will allow.

### NATURAL ENEMIES OF THE BUD MOTH.

The natural enemies of this pest must not be overlooked since they form no small element in its control. The enormous multiplication of the moth within the wire screen composing the cage as compared with neighboring trees outside, shows the remarkable effectiveness of birds and the larger insects in reducing its numbers. Within the cage numerous parasites were always in evidence. It was found that larvae or pupae left about the cage were invariably taken by ants which were always running up and down the trees

and over the ground. A number of instances came to my attention during the summer where these doughty little soldiers had found unprotected larvae and were struggling away down the tree with them. A small per cent of the pupa cases opened were found to contain Chalcid flies in various stages of existence. Usually these had devoured the pupae and were completing their transformations neatly enclosed in the pupae of their former hosts. Quantities of large gray spiders were always in and about the tree and in the crevices of the cage. In a number of cases the adult spider built her nest and laid her eggs upon leaves containing bud moth larvae. These spiders were most noticeable during the pupation period in July and it was found that the crevices of the cage were filled with cocoons of the bud moth containing adult larvae or pupae. Nests containing young spiders were invariably stored with them and the cocoons were speedily emptied by the young Arachnids. While it is never safe to rely entirely upon natural enemies for the control of the pest, yet they deserve a large share in the orchardists's consideration and should never be destroyed by him.

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## **SOME INSECTS TO BE WATCHED FOR BY OUR INSPECTORS AND FRUITGROWERS.**

We have attempted to bring together in the following pages information that will be of value to our horticultural inspectors, fruit-growers and others interested in the preventive campaign Montana is making against insect pests of fruit. We believe that the geographical arrangement of the valleys of Montana which have climatic conditions that permit of the successful growing of fruits make it possible to do much to prevent the introduction and spread of insects and fungus pests. The different fruit regions are so isolated one from another that pests from any one infested region in the state are scarcely more liable to be transferred to another than are the pests from an infested region outside of the state. It is therefore of the greatest importance that all persons interested in the fruit industry should acquaint themselves with the appearance of the pests that are most liable to be introduced. We have included in the list here discussed, various species that have appeared in one

or another locality while those that are already widely distributed and well known, such as the apple leaf-aphis, have been excluded.

Not all of the species in the list can be considered to be pests of first class importance in our climate but they are all species that for one reason or another, usually because they feed in the fruits that are liable to be shipped into the state or because they hibernate in or on some part of the trees that are shipped in as nursery stock, are liable to come across our borders incidentally in commercial practices.

### THE PEACH-TREE BORER.

Though the peach-tree borer shows a decided preference for peach trees it is also a pest of cherry, plum, nectarines and apricots. The insect is therefore of interest to the fruit-growers of Montana, though few peaches are grown. It is not probable that it will become a very serious enemy of cherries and plums, but it is thought best to include it in the list here treated.

The young larva burrows beneath the bark and sap wood during the first year of its life and passes the winter in this burrow. In the spring it resumes feeding, reaching full growth in May or June. In its hibernating condition it is liable to be transferred on nursery stock

It is a difficult pest to control and one that should be vigorously dealt with if it is found in Montana. Its presence on growing trees is indicated by gummy excretion from the bark at the points where its burrows touch the exterior.

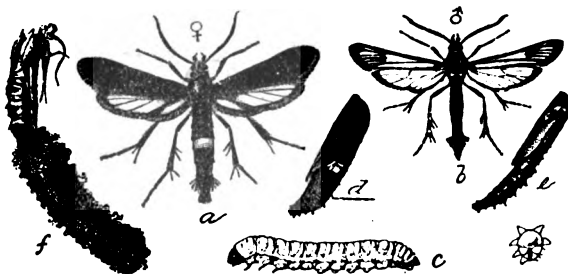


Fig. 2. The Peach-tree Borer: a, female; b, male; c, larva; d, e, female and male pupae; f, cocoon. (Marlatt, Circular 17, New Series, Div. of Entomology, U. S. Dept. of Agr.)

**THE FLATHEADED APPLE-TREE BORER. -**

The flatheaded apple-tree borer inhabits Canada and the United States and is a native American insect. It occurs in few places in Montana and in some cases has been very destructive. Young trees during the first two years after planting are particularly liable to attack since the beetle prefers for its host trees those that have been weakened from some other cause. The hot southwestern sun in the spring of the year often "scalds" the bark on the main stem of young trees. Trees thus affected are attacked and their destruction is completed.

Various forest and shade trees are attacked as well as apple, pear and peach among fruit trees.

The female deposits her eggs in cracks and crevices of the bark in the spring and early summer. The larva hatching from the egg bores through the bark and excavates cavities of varying shape and size in the sap wood. Small trees are often girdled. The larva life lasts from one to three years and it is while in the larval burrows that the insect is liable to be distributed on nursery stock. The appearance of the insect, magnified, is shown in the accompanying figure.

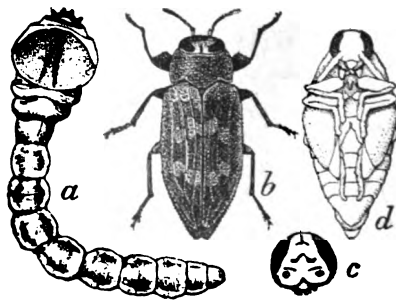


Fig. 3. Flat-headed Apple-tree Borer: a, larva; b, beetle; c, head of male; dk, pupa—twice natural size. (Chittenden, Circular 32, Sec. Series, Div. of Entomology U. S. Dept. of Agr.)

**ROUND-HEADED APPLE-TREE BORER.**

The round-headed apple-tree borer is much less frequently met with than the "flat-headed" species but its injury is more serious. Affected trees assume a sickly appearance and fail to make the proper growth. On the trunks may often be seen masses of the castings at the openings to the burrows. In some parts of the country this has been a very serious enemy to apple trees.

Besides attacking the apple it is found in various other woody plants including crabapple, quince and pear. Experience has shown that trees are very much more liable to be attacked if the trunks are surrounded by grasses, weeds or other vegetation.

The adults appear in the spring of the year and the females deposit their eggs as near to the ground as possible. The eggs hatch in about three weeks and the larvae work their way under the bark and feed for the first season in the sapwood. During the second season they feed in the deeper heartwood and in the third spring bore to near the surface where they transform to pupae the adult beetles appearing a little later. The adult is a beautiful insect measuring three fourths of an inch to an inch in length. The under surface of the body is silvery white while the upper surface is brown with two longitudinal white stripes.

This insect may be introduced into Montana in nursery stock. In looking for it the bases of the trunks should be closely examined.

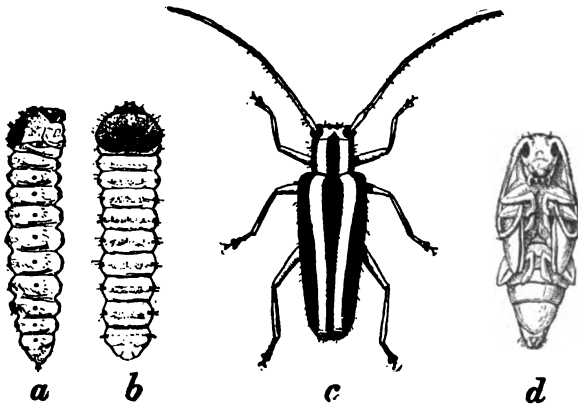


Fig. 4. Round-headed Apple-tree Borer: a, larva, from side; b, from above; c, female beetle; d, pupa; all enlarged one-third. (Marlatt, Circular 32, Sec. Series, Div. of Entomology, U. S. Dept. Agr.)

### THE BRONZE APPLE-TREE BEETLE. I

This beetle, so far as we are informed, is confined to the Northwestern States and its economic status is not fully determined. Mr. F. H. Chittenden has given us a good account of what is known regarding the pest, in which he calls attention to various complaints regarding it from Washington and Oregon.<sup>2</sup> Professor C. V. Piper formerly from Pullman, Washington had sent specimens to Mr. Chittenden reporting serious damage to the apple industry of Washington. The same gentleman later reported that his first suspicions regarding the weevil had been much allayed by the discovery of the fact that its injuries were apparently secondary to the fungus disease known as "canker" or "blackspot".

In an orchard near Missoula an assistant, Mr. Jones, found last summer specimens which on being submitted to Dr. Howard of the Bureau of Entomology proved to be this beetle. The owner of the orchard is very jealous over the freedom of his trees from pests and has repeatedly sent this office specimens for identification. The "canker" disease has not yet been detected in his orchard though the beetle in question is fairly abundant on his trees.

These facts cannot be considered as evidence that the beetle is secondary to the fungus disease yet they point in the opposite direction. To the writer it seems possible that the fact that Prof. Piper

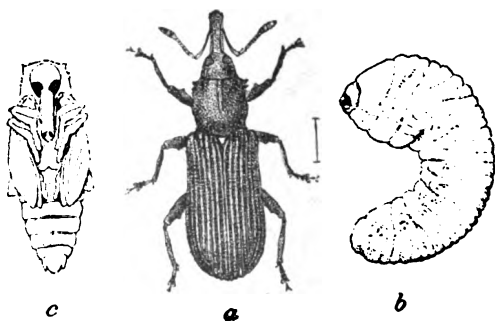


Fig. 5. The Bronze Apple Tree Borer: a, adult weevil dotted portion of size line showing length of snout; b, larva; c, pupa—six times natural size. (Chittenden, Bulletin 22, New Series, Div. of Entomology, U. S. Dept. of Agr., 1900).

1. *Magadalis aenescens* Lec.
2. Bulletin 22, N. S. Div. Ent., U. S. D. A., page 39.

found the fungus disease and the beetle at identical spots on apple trees may be explained by the germinating spores of the fungus disease finding in the punctures into the bark made by the beetles in depositing their eggs, suitable places for gaining access to the under layers of the bark. If this be the case then the weevil is the primary cause and the fungus secondary.

Considering what information we now have regarding this borer, it is apparent that in the interests of the apple growers it will be well to watch for it and become familiar with its habits.

The beetle is small, black, and has a snout. See the accompanying figures.

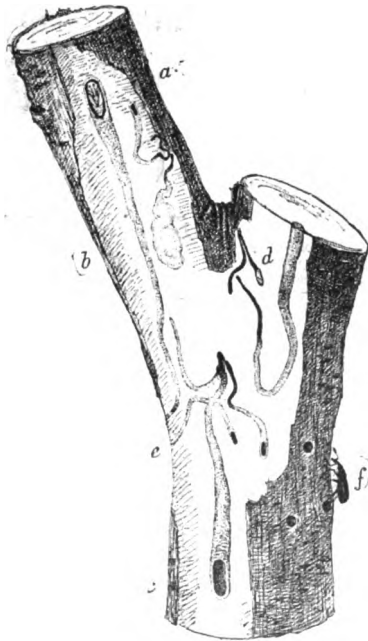


Fig. 6. Work of the apple tree borer;—a, pupa in its cell; b, exterior of pupal cell; c, empty cell; d, parasitic pupa in its cell; e, two empty cells of parasite; f, beetle and holes made by beetles in their escape—all natural size. (Chittenden, Bulletin 22, New Series, Div. of Entomology, U. S. Dept. of Agr., 1900).

## THE APPLE TWIG-BORER. I.

The apple twig-borer also known as the grape cane borer is an enemy to the grape, apple, pear, peach, plum, forest and shade trees, and ornamental plants. It is especially destructive to the grape.

This has been a very common and destructive pest in the states along the Mississippi river from Iowa southward. It also occurs eastward from the Mississippi river to the coast.

In the fall and winter the adults of this insect bore into the twigs of its host plants as shown at "d" of the accompanying figure. Entering these stems the beetles hibernate there. It is thus seen

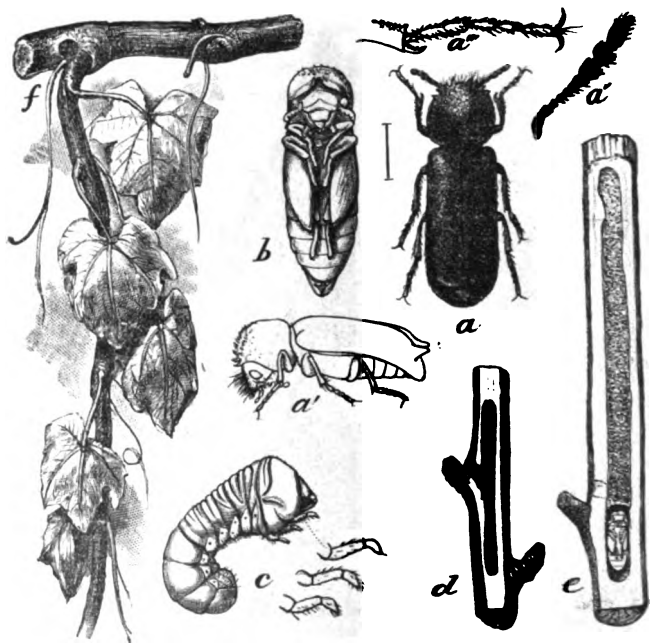


Fig. 7. The Apple Twig-borer: a, beetle, dorsal and lateral view. b, pupa from beneath; c, larva from side, with enlargements of the thoracic feet; d, burrow in apple twig made by adult; e, larval gallery in tamarisk, with pupa in cell at end; f, injury to young shoot and cane, showing the entrance to burrow of beetle near f and the characteristic wilting of the new growth—all much enlarged except d, e and f. (Marlatt, Yearbook, U. S. Dept. of Agr. 1895.)

# I. *Amphicerus bicaudatus*.

that from this fact the apple twig-borer is another pest that is particularly liable to be transferred on nursery stock. The eggs are laid in the early spring months, the beetles leaving their hibernating quarters for this purpose. The larva bores through the center of the twig until fall when it pupates later transforming to a beetle and going into hibernation as above described. There is but one brood.

The adult of the insect which is the form liable to appear on nursery stock is about  $\frac{1}{2}$  inch in length, cylindrical in general shape and brown in color.

### THE FRUIT-TREE BARK-BEETLE.

The fruit-tree bark-beetle is an introduced insect that attacks the bark of plum, peach, cherry, and apple trees. The bark may be thickly peppered with fine holes as though by fine bird shot. See figure 9. These are the entrance and exit holes of the small beetle illustrated, greatly enlarged at Figure 8 a and b. The grubs excavate narrow galleries in various directions under the bark often killing a tree or part of its branches. The beetle usually attacks only sickly or unthrifty trees.

The adult beetles appear in the spring and begin burrowing through the bark. Upon reaching the sap wood, feeding as she goes, the female constructs, partly in the bark and partly in the wood next to it, a vertical gallery or "brood chamber", and along the sides of this at short intervals she gnaws little pockets in each one of which she deposits an egg. The very minute, whitish, grub-like larvae that hatch from these eggs excavate galleries that start out at right angles to the brood chamber. These side galleries soon

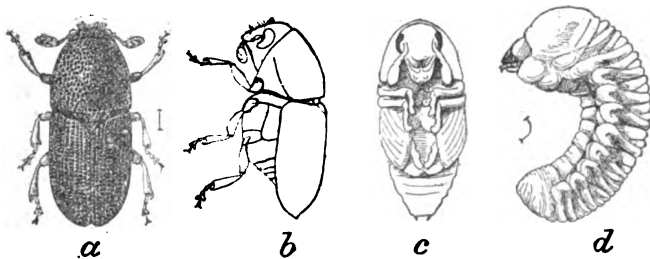


Fig. 8. The Fruit-tree Bark-beetle: a, adult beetle; b, same in profile; c, pupa; d, larva—all magnified about ten times. (Chittenden, Circular 29, Sec. Series, Div. of Entomology, U. S. Dept. of Agr.)

diverge, however, and increase in size as the growing larva gnaws its way away from the main burrow. Most frequently the insect lives in such numbers, with its larval galleries so closely packed together and so much confused with others that it is with difficulty that individual galleries can be distinguished.

The larvae transform to pupæ at the end of their galleries. The number of generations varies in different parts of the country between one or two and four.

The species is a fairly common one in the eastern part of the United States and may appear on nursery stock shipped in for planting in Montana.



Fig. 9. Work of The Fruit Tree Bark-beetle in twig of apple—natural size. (Chittenden, Circular 29, Sec. Series, Div. of Entomology, U. S. Dept. of Agr.)

### THE PEACH TWIG-BORER. I.

In Montana markets one may occasionally find peaches containing the larvae of this insect and from its peculiar hibernating habits it is greatly facilitated in its distribution on nursery stock.

The peach twig-borer is a pest of stone fruits and is very widely distributed. From what is known of its habits it seems evident that should this pest gain access to the peach, plum, and cherry trees of this state much injury might result.

The presence of this insect on nursery stock is indicated by bits of frass attached to the bark frequently in the crotches of branches of twigs. Each of these bits of frass covers the entrance into a small burrow within which a young larva may be found. The larva at this stage is of yellowish color with the head, the top of the segment just behind it, and the posterior end of the body above, almost black. In the spring when the shoots have begun to grow the young larvae leave their hibernating quarters and bore into the

tender leaf-shoots. When one leaf shoot has dried so as to become unsuitable for food another is attacked. The larva becomes full grown in about two weeks and pupates in a rather unsubstantial cocoon among withered leaves or on the surface of the bark. The moth issues in May and is very small and grayish. Two later broods occur, the larvae boring into the twigs as described or into the fruit. The larvae of this second brood construct the burrows in the bark in which to hibernate.

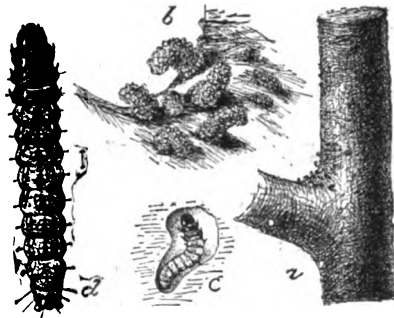


Fig. 10: The Peach Twig-borer: a, twig of peach, showing in crotch minute masses of chewed bark above larval chambers; b, latter much enlarged; c, a larval cell, with contained larva, much enlarged; d, dorsal view of young larva, more enlarged. (Marlatt, Farmer's Bulletin 80, U. S. Dept. of Agr., 1898.)

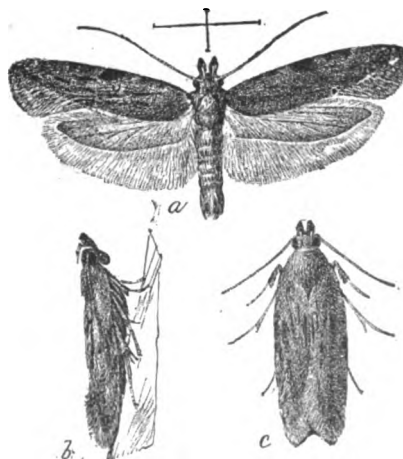


Fig. 11: The Peach Twig-borer: a, moth with spread wings; b and c, same with wings closed, illustrating position normally assumed—all much enlarged. (Marlatt, Farmer's Bulletin 80, U. S. Dept. of Agr., 1898.)

## THE STRAWBERRY CROWN MOTH. I.

The Strawberry crown borer is a dangerous enemy to the strawberry, blackberry, and raspberry. The adult is a member of the group known as clear winged moths on account of the transparency of the wings. They resemble wasps in their form, markings, and actions.

This species appears to be native to the United States and has been recorded by the Bureau of Entomology at Washington from California, Nevada, Colorado, and Texas.

A lady from Stevensville, Montana, made complaint of what is very likely this insect but no material could be obtained from which to make a determination of the species though an insect which was plainly a Sesiid from the manner in which it left the pupa shell protruding from the stems just above the earth. This pest had practically destroyed her entire patch of blackberries.

This again is one of the insects which is liable to be introduced on nursery stock. The partly grown larvae pass the winter in the crowns of the host plants. Just before the emergence of the moths the pupa works itself part way out through the opening previously constructed by the larva and the shell of the pupa is left at the opening when the moth departs. This is an insect that is not easy to control and its advent should be guarded against.

## THE WOOLLY APHIS.

The woolly aphis is an insect much feared by fruit growers but after six years of experience in the state of Montana during which time we have learned of its presence fairly common in the state we feel warranted in saying that under the climatic conditions found here this insect will probably not be a serious pest. However, it is warrantable to watch for it and deal vigorously with it when found.

Two forms of the insect exist, an areal form feeding on the parts of a tree above the earth, and a root form feeding on the smaller roots on which they produce irregularly shaped galls.

The areal form often attacks partly healed wounds in the bark.

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1. *Sesia rutilans* H. Edw.

The bodies of this form are covered by a white flocculent matter, and when several of the insects are huddled together as is usually the case with this louse, the white blotches become conspicuous objects.

The insects' most natural means of wide dissemination is on the roots of apple trees intended for planting.

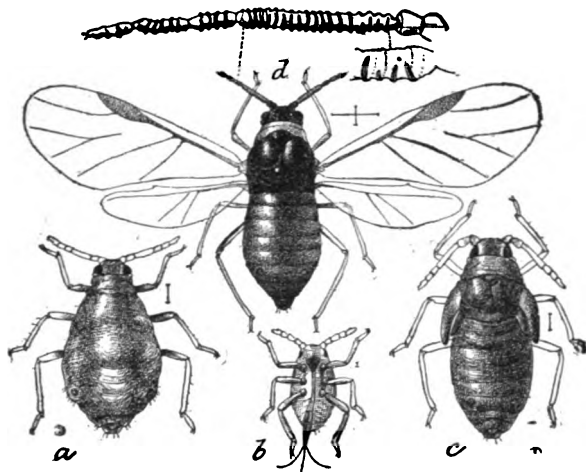


Fig. 12. Woolly aphid: a, agamic female; b, larval louse; c, pupa; d, winged female with antenna enlarged above; all greatly enlarged and with waxy excretion removed. (Marlatt, Circular 20, Sec. Series, Div. of Entomology, U. S. Dept. of Agr.)

### THE SAN JOSE SCALE.

The San Jose scale is an oriental insect but it was first noticed in literature from the town in California from which it took its name. It is now of world wide distribution and has been the cause of much loss and expense. Of small size and insignificant appearance but very tenacious of life and endowed with great powers of multiplication, it has been an enormous factor in the fruit growing and nursery businesses.

The San Jose scale is a general feeder, attacking nearly every variety of deciduous fruit trees. In the east it has done its principal damage to peach and pear but its full list of food plants includes many ornamental plants and shade trees.

It passes the winter as a partly grown female. In the spring young are produced which wander off and finding suitable places on

the plant settle down and begin feeding. Other broods follow, the number varying with the latitude.

The female scale is circular about one-twelfth of an inch in diameter when full grown and only slightly convex. It is gray or blackish sometimes with a yellowish tinge.

The mature male is oblong-oval, its length being about one-half the diameter of the female scale, black or grayish and having in the center a nipple-like prominence. See the accompanying figure.

It is a source of wonder to many that an insect so small as the San Jose scale can overcome a tree. The explanation is found in the fact that the life of the tree exists just under the bark upon which the countless numbers of scales settle inserting their beaks into the vital tissues just under the surface. While these insects

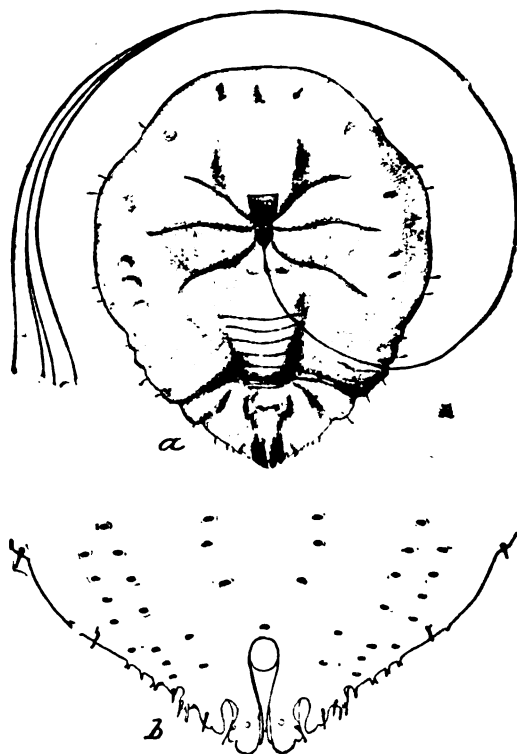


Fig. 13. San Jose Scale: a, adult female showing very long sucking setae; b, anal plate showing characteristic ornamentation of edge; greatly enlarged. (Howard and Marlatt, Bulletin 3, Div. of Entomology, U. S. Dept. of Agr.)

may not kill a tree outright they may so blight it as to render it useless.

The question is often asked: "Would the San Jose scale become a serious pest in the latitude and under the climatic conditions of Montana"? While there is room for a reasonable doubt that this scale would be a serious menace to Montana fruit trees, the fruit growers should keep the benefit of the doubt on their side and urge the enforcement of the laws that are intended to prevent its admittance and should watch for, and if possible, suppress it as it comes.

It is true that in localities where it thrives methods are now devised whereby it may be held in control but the application of these means is expensive and the presence of the pest is a cause of anxiety to the owner of the infested premises.

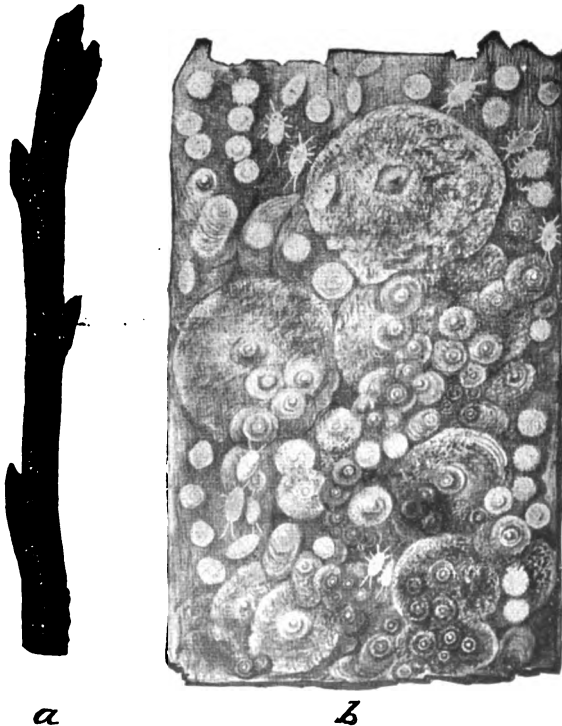


Fig. 14. San Jose Scale: a, infested twig natural size; b, as the scales appear under a hand lens. (Howard and Marlatt, Bulletin 3, New Series, Div. of Entomology, U. S. Dept. of Agr.)

**PUTNAM'S SCALE INSECT. 1.**

Putnam's scale insect is widely distributed and feeds on all orchard trees. It is similar to the San Jose scale in general appearance but it may be easily distinguished from that species by the orange colored spot (the exeuvia) on the scale of this species and the less circular outline.

This insect is single brooded. It passes the winter in a nearly full grown condition. The young begin to hatch in July and continue during the month.

Putnam's scale has been taken by the writer near Missoula in an old orchard and on an old neglected tree in the city of Missoula.

**THE GREEDY SCALE INSECT. 2.**

Smith cider and other varieties of apples coming into the Montana market from California occasionally bear specimens of this scale insect. We have seen apples with many specimens of this species crowded in at the blossom and stem ends. It is not a species that could survive our climate and need not be feared as a pest on apples in Montana. It is common in greenhouses where it reproduces in great numbers.

The scale is gray in color but somewhat transparent so that when covering the yellow body of the living female the scale has a yellowish tinge. When removed from the bark or fruit a white scar is left.

The adult female scale is very convex and among scale insects is conspicuous for this characteristic.

It is widely distributed in the United States and is without much doubt an introduced species.

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1. *Aspidiotus ancyclus* Putn.
  2. *Aspidiotus camelliae* Boisd.

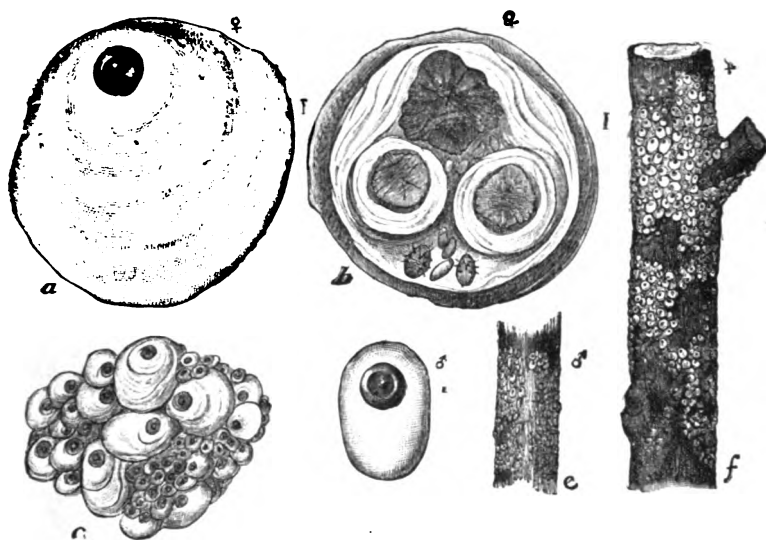


Fig. 15. The Greedy Scale Insect: a, female scale from above; b, same from below; c, mass of scales as appearing on bark; d, male scale; e, male scales on twig; i, female scales on twig; e and f, natural size; c, considerably enlarged; a, b, d, greatly enlarged. (Howard, Yearbook, U. S. Dept. of Agr., 1894.)

### THE OYSTER-SHELL BARK LOUSE.

The oyster-shell bark louse is the best known of any of the orchard scales. It probably came originally from Europe but it is now known throughout the world. Like the other scale insects here discussed it is particularly adapted to distribution on nursery stock.

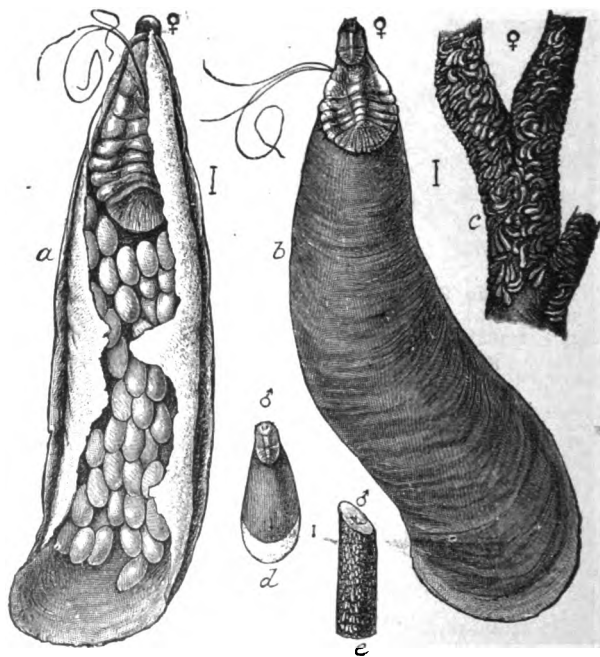
This insect attacks a variety of food plants including apple, pear, plum, quince, hawthorn, raspberrq, currant, linden, willow, cottonwood, poplar, wild cherry, rose, lilac, and white birch. Many of these it attacks so severely as to threaten their lives.

The scales of the two sexes are quite different in size and appearance. The female scale is elongated (see "a" of the figure) rounded on the upper surface, flat beneath, and brownish in color. The male scale is much smaller but of the same color.

If one of the female scales be turned over during the winter there may be seen numerous very minute white eggs closely packed

together. With the awakening of nature in the spring these eggs hatch into minute whitish larvae which crawl out from under the parent scale and go to suitable spots for settling down. These larvae go mainly to the tender new growth. In the North there is but one brood but farther south there are two.

This scale insect is present in a few localities in the state and has been very prolific and troublesome.



eggs; b, same from above, greatly enlarged; c, female scales; d, male scales, natural size. (Howard, Year-book, U. S. Dept. of Agr.)

Fig. 16. Oyster-shell Bark-louse: a, female scale from below showing

### THE SCURFY BARK LOUSE.

The scurfy bark louse is an elongated insect similar in shape to the oyster shell bark louse but the substance of the scale is thinner in texture and white in color. (See the accompanying figure).

The winter it passes as eggs closely packed under the scale. The eggs number from thirty to seventy-five and are of a reddish purple color. In the climate of northern United States there is but one brood. The eggs hatch in the spring and by fall the life cycle, which is similar to that of the oyster shell louse, is completed.

This species is not very liable to be introduced on nursery stock. The white color of the scales renders them conspicuous objects and the nurseryman who desires his trees to have a clean healthy appearance will usually notice them and remove them before shipping. The oyster shell bark louse, on the other hand, is not noticeable, its color being similar to that of the bark.

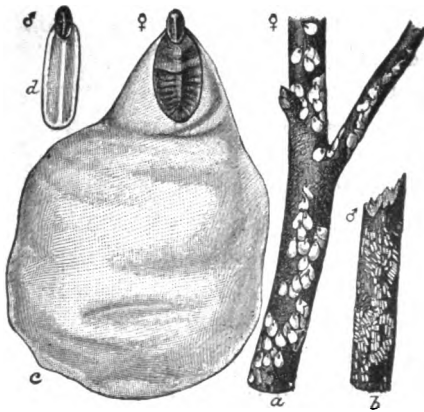


Fig. 17. Scurfy bark-louse: a, c, females; d, males; a, b, natural size; c, d, enlarged. (Howard, Year-book, U. S. Dept. of Agr.)

### OTHER SCALE INSECTS.

There are a few other scale insects that might be discussed in this paper but which are not liable to often appear on nursery stock arriving in Montana.

Scale insects are not easily identified except by the expert, and much may depend on the identity of a scale that is found in an orchard or nursery. The Experiment Station will gladly make determinations of scale insects or any others that are sent in.

### THE CODLING MOTH OR APPLE WORM.

The well known apple worm is enormously destructive to apples and pears in the United States. It is said to destroy, on an average, about one half of the apple crop of the United States annually. Its injuriousness is much less in Montana than in some other states where the climatic conditions are more favorable to it but we believe that the percentage of damage under ordinary conditions will vary from about 15 to about 55 when nothing is done to hold it in check. The apple is Montana's most successful fruit and the codling moth its worst insect enemy.

The codling moth is two-brooded in Montana. The first brood of the season are laid about the middle of June. By the latter part of July wormy apples become noticeable. The second brood begins its operations about the 10th to the 15th of August and is principally injurious to fall and winter varieties.

It occurs in a few isolated localities in the following counties: Flathead, Sanders, Missoula, Ravalli, Broadwater, Yellowstone, and Custer.

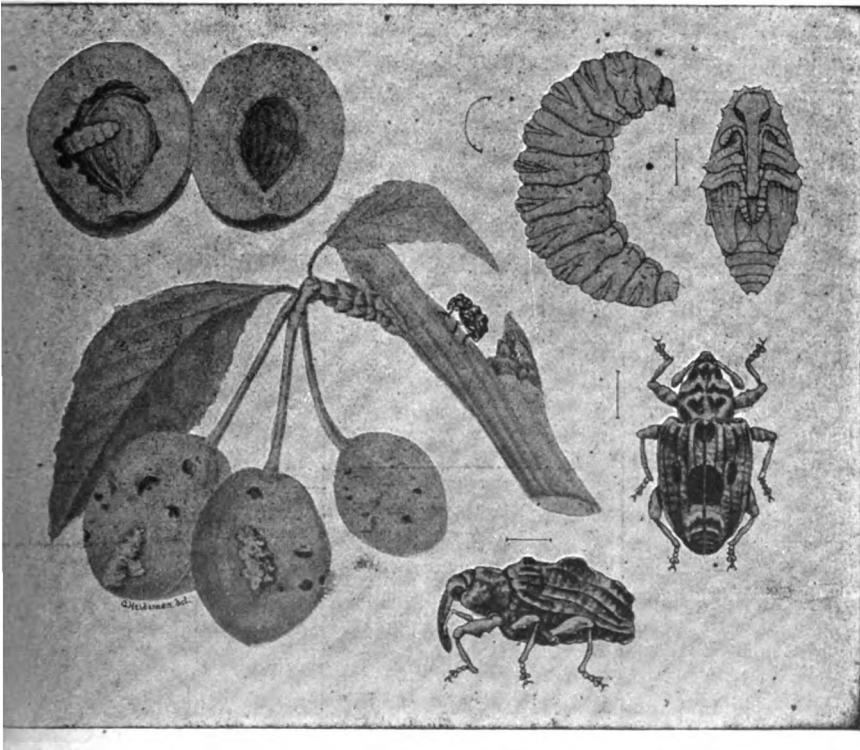
For means of wide distribution the codling moth is mainly dependent on traffic in fruits. It has extended itself throughout practically the whole world and is believed to have done so almost entirely through the medium of fruit packages. It is a particularly dangerous practice to carry second hand fruit boxes into the orchard to be filled again. This practice is now prohibited by law.

Fruit growers should heartily co-operate with the state authorities in the campaign against this pernicious insect.

### THE PLUM CURCULIO.

The plum curculio is a serious enemy to stone fruits and is partial to plums. The accompanying illustration shows its method of injuring plums. It is an insect pest of first class importance and has in some sections practically killed the industry of plum growing. Besides attacking the plum it breeds in great number in cherries, peaches, appricots, nectarines, quinces, apples, crabs, and haws.

Its means of distribution is principally in the larval stage through



18. The Plum Curculio, (Lugger).

the medium of crated cherries shipped from one locality to another. It hibernates as an adult and may be distributed in this stage.

Its presence may be detected by the characteristic crescentic slits that it makes on the young fruits that it attacks and by the grub in the fruit. However, there are other insects that feed in stone fruits.

This is a native American insect. It is said to occur near Stevensville, Montana, and in Yellowstone County.

### TENT CATERPILLARS.

There are about five species of tent caterpillars that are liable to be found in Montana. We have already had a few complaints of these insects and the writer saw a nest of what was probably the common eastern species, (*Clisiocampa americana*) in Missoula county. Within certain limits the caterpillars of all these species appear alike and the accompanying illustration will give a reliable idea of the general appearance.

The winter is passed in the egg stage. The egg clusters shown in the accompanying figure are liable to occur on any bill of nursery

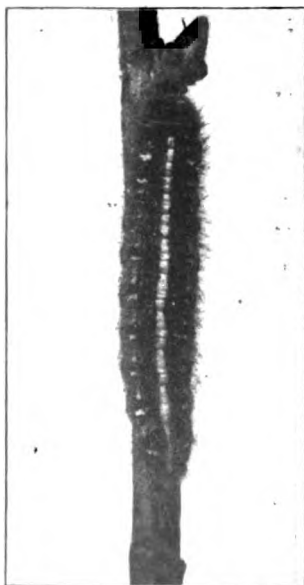


Fig. 19. *Clisiocampa americana*: top view of full grown caterpillar. (Lowe, Bulletin 152, N. Y. Agl. Exp. Sta.)

stock. One would not be warranted in rejecting the shipment or burning it. The egg clusters are easily removed, or if they escape detection and hatch in the trees after they are set out, the nests are conspicuous and easily destroyed. There is little excuse for allowing this insect to continue in an orchard year after year. The nests may be removed caterpillars and all without injury to the trees. Wild cherry trees in the vicinity of the orchard should be kept free from the nests so as to prevent infection of the fruit trees.

The caterpillars hatch from the eggs early in the spring and congregate in a forked limb or branch and spin a nest or "tent". This is their home from which they migrate for the purpose of feeding.

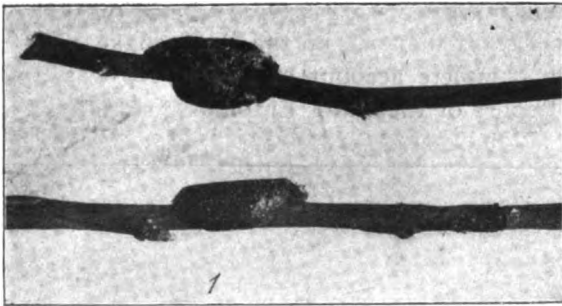


Fig. 20. Egg masses of *Clisiocampa americana*. (Lowe, Bulletin 152, N. Y. Agr. Exp. Sta.)

## THE BUD MOTH. I.

The bud moth is a small, brownish, hairless, black headed caterpillar about  $\frac{1}{4}$  of an inch long which feed in the buds of apple and pear in the spring of the year, and after the buds have expanded,

### 1. *Tmetocera ocellana*.

on the leaf and flower buds which they destroy. Later in the season the new brood feeds on the epidermis of the leaves. The injuries from the species are due to the destruction of the fruit buds and to the deformities induced by the eating off of terminal buds.

The adult is a moth somewhat resembling the codling moth. The eggs are laid on the foliage about the first of July. The winter is passed as a partly grown larva in a hibernaculum constructed for the purpose. These hibernacula are very difficult for an inspector to detect and the insect is one that may readily be distributed on nursery stock, scions, etc.

The bud moth has been periodically injurious in the East. In another part of this report are notes on the life-history and means of controlling its ravages.

The species occurs at Missoula where it has been very injurious. I have also found it on a few trees twelve miles up the Bitter Root Valley and for a short distance up the Rattlesnake Valley.

A reasonably complete account of this insect was given in the First Annual Report of the State Entomologist, (1903).

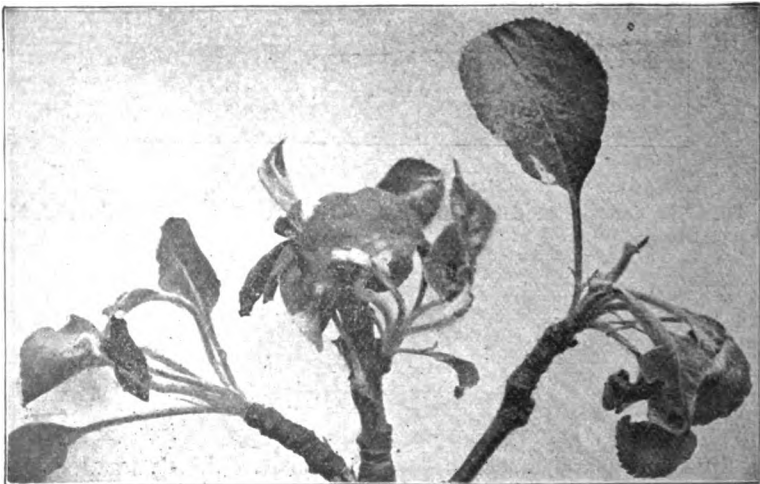


Fig. 27. Work done by bud moth larvae early in season on apple twig. (Slingerland, Bulletin 147, Conn. Univ. Experiment Station.)

### THE PEAR AND CHERRY SLUG.

The larvae or slugs of this insect feed on the upper surface of the leaves leaving a network of veins and the lower cell layers. The leaves so affected turn brown, die and drop off. Whole trees or whole orchards may be thus defoliated. A second growth may be put out thereby weakening the tree so that no fruit is produced the next season. In the early spring the adults may be seen about the trees where they gather for the purpose of laying their eggs. The larvae soon hatch and feed on the leaves. They are at first white, but they soon have a shiny olive colored fluid on their bodies.

The insects feed on pear, cherry, and plum and about thirty other plants. It shows a preference for pear.

The species occurs throughout Europe and America and in many of the British colonies.

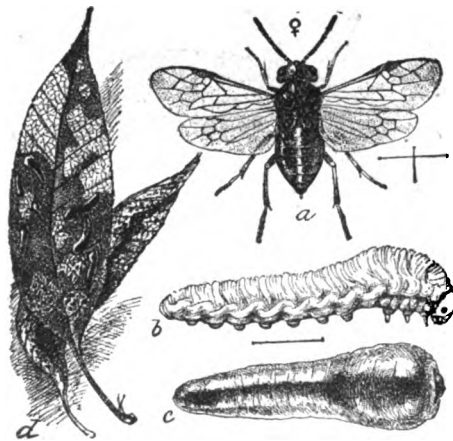


Fig. 22. Pear and Cherry Slug: a, adult saw-fly, female; b, larva with slime removed; c, same in normal state; d, leaves with larvae, natural size; a, b, c, much enlarged. (Marlatt, Circular 26, Sec. Series, Div. of Entomology, U. S. Dept. of Agr.)

### THE PEAR-LEAF BLISTER-MITE.

The pear-leaf blister-mite is another pest that is particularly liable to be distributed on nursery stock, scions, etc. The almost microscopic mites hibernate under the scales of the buds and their detection through inspection is out of the question.

In the spring as the young, tender leaves are being put forth the over-wintered mites pass to the under side of the leaves and produce whitish or reddish blisters under which they later produce young which migrate and cause new blisters.

The pest is severe on individual trees but does not spread rapidly. Over short distances the young might be carried on the feet of birds or might be blown with the fallen leaves late in the season.

The blisters, often highly colored and usually arranged in rows parallel with the mid rib, one row on each side, are characteristic. This pest occurs in some of the fruit growing regions of Montana.

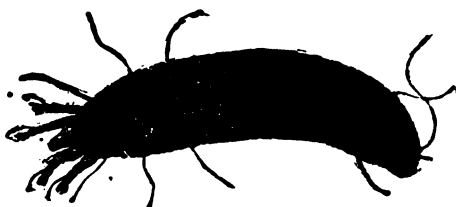


Fig. 23. The Pear-leaf Blister-mite: greatly enlarged. (Comstock, Manual for the Study of Insects, 1897.)

### THE STRAWBERRY LEAF-ROLLER. I.

The strawberry leaf-roller is a fairly well known pest in some parts of the United States. In the state of Washington it has been looked upon as their most serious insect enemy of strawberries. Though it has been in Montana for a number of years we have no record of great injury from it. It occurs at Missoula, Helena, and Miles City. It receives its name from its habit of rolling and crumpling the leaves of its host-plants. The larva which is small

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1. *Phoxopteris comptana* Frol.

and of a greenish color lives within the rolled or crumpled leaves feeding from the inside. When abundant, the larvae not only eat parts of the foliage but cause the remainder to turn brown. The larvae are very active and when taken into one's hand quickly wriggle out and drop to the ground.

There are two broods, one appearing in June and the other in August.

The larvae feed on the foliage of strawberry, raspberry, blackberry and various other plants.

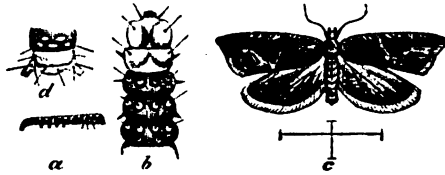


Fig. 24. The Strawberry Leaf-roller: a, larva, natural size; b, anterior end of larva, seen from above, enlarged; c, moth, enlarged; d, posterior end of larva, seen from above, enlarged. (First Rept. Insects of Mo., Riley, 1869.)

### THE CHERRY FRUIT-FLY. I.

The plum curculio is responsible for most "wormy" cherries but "cherry fruit-fly" may appear in the market fruits and if in the market is liable to escape to growing cherries. The cherry fruit fly as its name indicates is a fly and it is the larva or maggot that causes the damage. The work of the grub of the plum curculio is usually apparent from the exterior of the cherry, but in the case of this maggot the cherries may from the outside appear to be perfectly sound.

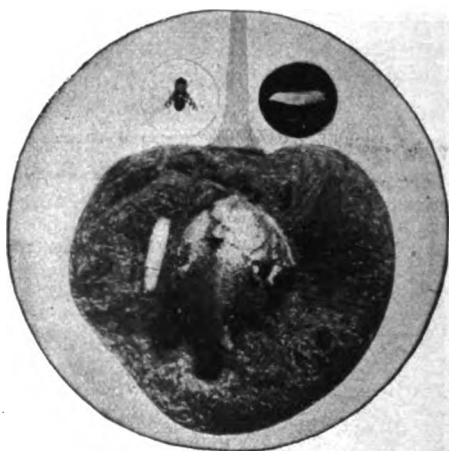
The cherry maggots are very light yellow in color and of the shape and size shown in the small black circle, above, in the accompanying figure.

The body of the fly is black and the head and legs are of a light yellow color. The wings are crossed by four blackish bands and have a blackish spot at the tip.

This insect is not very well known as a pest of cherries. It has been reported only from the eastern states. It is, however, one of

the insects that our Montana cherry growers should be on the lookout for.

The winter is passed by the immature insect in the ground. If this pest becomes established in Montana it will most likely be through the introduction of infested cherries. Wormy cherries rejected from those pitted for canning and thrown out on the refuse pile would furnish all the necessary conditions for the infection of any cherry trees in the vicinity that might be in bearing the next season.



**Fig. 25. The Cherry Fruit-fly:** Section of a cherry, enlarged to show the maggot and the nature of its work. The small figures above show the maggot and its parent, the fruit-fly, natural size. (Slingerland, Bull. 172, Cornell Univ. Exp. Sta., 1899.)

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